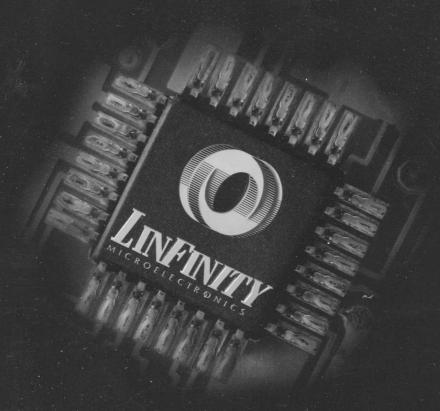
# COLINFINITY MICROELECTRONICS



THE INFINITE POWER OF INNOVATION 1996/1997 DATABOOK

# PRODUCT DATABOOK

1996/1997

11861 Western Avenue Garden Grove, CA 92841 714-898-8121, 714-893-2570 Toll Free: 800-LMI-7011



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**Bold =** New Product, \***Bold Italic** = Preliminary



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Bold = New Product, \*Bold Italic = Preliminary



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## Introduction

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## Introduction

## A MESSAGE FROM THE PRESIDENT





GENERAL INFORMATION / POLICIES

## MISSION STATEMENT

LINFINITY MICROELECTRONICS' MISSION IS TO PROVIDE PRODUCTS AND SERVICES THAT HAVE AN ADDED VALUE TO OUR CUSTOMERS.

## QUALITY POLICY

LINFINITY MICROELECTRONIC'S GOAL IS TO PROVIDE OUR CUSTOMERS WITH PRODUCTS AND SERVICES WHICH CONSISTENTLY ACHIEVE A LEVEL OF QUALITY That *Meets* Or *Exceeds* Our Customers' Requirements.

Our Goal Is Continuous Improvement, Excellence In All Our ENDEAVORS AND TOTAL CUSTOMER SATISFACTION.

## DEVELOPMENT PRINCIPLES

ALL PRODUCTS AND SERVICES WE PROVIDE MUST MEET THE FOLLOWING CRITERIA:

- ADD A PERCEIVED VALUE TO THE BUYING CONSUMER
- BE DIFFICULT FOR A COMPETITOR TO IMITATE
- BE LEVERAGABLE IN MANY DIVERSE MARKETS

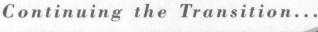
To Add Value, We Must Significantly Impact AT LEAST TWO OF THE FOLLOWING CONSUMER CARE-ABOUTS:

- Performance
   Ease Of Use
   Power Consumption
  - Size
- Cost



## Introduction

## INTRODUCTION TO LINFINITY





## WHAT ABOUT THE NAME CHANGE?

By now you've noticed from the front cover that we've changed our name from Silicon General Semiconductors to Linfinity Microelectronics Inc. Why? How will it affect me? and What does the name mean? are the most commonly asked questions from our customers. The following paragraphs help to explain these questions.

Effective June 28th, 1993, Silicon General Semiconductor adopted the new name Linfinity Microelectronics Inc. There were several reasons for the name change. To begin with, we have become a wholly owned subsidiary of the parent Silicon General Corporation (effective 11-1-93 the parent Silicon General Corporation changed it's name to Symmetricom, Inc.). The Silicon General Corporation

operated a semiconductor division (now a subsidiary, Linfinity Microelectronics Inc.) in Garden Grove, California, and a telecom systems division (Telecom Solutions) in San Jose, California. This action required a name change on our part. But more important than changing our name, we wanted to signify a new dedication to develop value-added products and services that are market driven. These products and services will offer high-growth potential for our company, our employees and, most importantly, our customers. We want to send the message of a bright future, a future with new and innovative products helping our customers reach new levels of functionality, and performance in their future-generation products.

## WHAT'S IN A NAME?

And where did the name Linfinity come from? Silicon General's history is deeply rooted in Linear integrated circuits as are our marketing, design, fabrication and product engineering experiences. Linfinity's future is focused on Linear and Linear driven Mixed Signal products. The cumulative experience of the old and new employees of Linfinity runs

into the thousands of years. We are dedicated to putting this experience to work in driving Linear performance to new levels using our best and brightest ideas. Linfinity is the combination of the <u>Lin</u>ear focus and the <u>infinite</u> possibilities and opportunities the analog world offers .......

#### LINFINITY

#### WHAT ELSE HAS CHANGED?

Maybe it's best to start out by saying what isn't changing. There are no changes to the existing products and services we provide you, our valued customers. The people and factory remain the same as does our dedication to provide our best efforts in all our endeavors. However, we have changed our business direction and strategy. We are expanding the value-added products and services in markets we currently serve such as power supply systems,

while adding product lines to service new, high-growth markets such as signal conditioning, data communications, and motion control systems. Linfinity is focusing its resources on market driven Linear and Mixed Signal products for the commercial, industrial and military markets that will drive the systems of this decade as well as those of the next century. This is an exciting time for Linfinity and our customers.



## Introduction

## INTRODUCTION TO LINFINITY

## A MESSAGE FOR OUR NEW CUSTOMERS

Over the years Silicon General Semiconductors has done business with a wide variety of customers in the Commercial, Industrial and Aerospace markets with a clear emphasis on Aerospace. Linfinity's new direction places emphasis on developing products for the Commercial

and Industrial Markets, while still making products available for Aerospace use. So if you are a new customer from the Commercial or Industrial market you are probably not acquainted with our technological and manufacturing capabilities.

## ----- Process Capabilities

To that end, first and foremost we are a Linear house whose wafer fabrication technology is integral to providing leading-edge products. Linfinity's wafer fabrication is located in Garden Grove, California, roughly two blocks from our headquarters on Western Avenue in Garden Grove. Our technology is based on three mainline processes, a Linear Bipolar, CMOS and a Mixed Signal BiCMOS process from which we offer a variety of voltage, speed and density options. We are continuously upgrading and adding options to our fabrication technologies so we encourage you to contact us for more detailed specifications on these processes.

## ----- Assembly/Test Capabilities

In the area of packaging, Linfinity offers a wide range of surface mountable and thru-hole packages, all of which are described in greater detail later in this databook. Linfinity's Garden Grove facility handles a variety of plastic and ceramic packages with full production and prototyping capabilities combined with production testing. In fact, our facility has been certified to QML status of MIL-I-38535. See the quality section later in this databook for full details. Additionally, Linfinity's high-volume packaging and test capability resides in several pacific rim countries. Packaging options include surface-mountable plastic and ceramic in addition to their thru-hole compliments. As detailed in the Package Information section, Linfinity has the latest in packaging technology, including TQFP (thin quad flat pack) for high pin count mixed signal applications and the very

thin TSSOP (thin small shrink outline package) for lower pin count analog applications. Capacity wise, Linfinity has volume capability in both wafer fabrication and assembly/ test facilities sufficient to meet today's commercial demands. In addition to the process capabilities required by our military certification, we also offer the following process options for our space-level and Ultra-High Reliability applications:

- PIND Testing
- Wafer Lot Acceptance
- · X-Ray
- Customer Source Inspection Program
- Radiation Testing Custom Data Capability

So if you are a new customer, welcome to the world of Linfinity Microelectronics. We look forward to doing business with you.

#### SUMMARY

We at Linfinity value our customers and are working tirelessly to provide better products and services to meet our industry's demanding requirements for performance, quality, reliability, availability and value.

This is a new and exciting time for us as we look to meet the demands of the Linear and Mixed Signal markets of the future. Come grow with us by putting the "Infinite Power of Innovation" to work for you.



## Notes

## MESSAGE FOR OUR NEW GUSYONERS

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- a Tellay Christoper South Inspection Program

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Introduction

Quality

2

**Working With Linfinity** 

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Part Number Selection / Info

**Power Supply Circuits** 

**Data Communication Circuits** 

**Signal Conditioning Circuits** 

**Motion Control Circuits** 

Other Linear Circuits Other Linear Circuits

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QUALITY AND RELIABILITY

# QUALITY POLICY

LINFINITY MICROELECTRONIC'S GOAL IS TO PROVIDE OUR
CUSTOMERS WITH PRODUCTS AND SERVICES
WHICH CONSISTENTLY ACHIEVE A LEVEL OF QUALITY
THAT MEETS OR Exceeds Our Customers'
REQUIREMENTS.

Our Goal Is Continuous Improvement,
Excellence In All Our Endeavors And Total
Customer Satisfaction.

#### QUALITY AND THE LINFINITY STANDARD

Signal Condianning Circuits

Linfinity Microelectronics Inc. has instituted a program of Continuous Quality Improvement in all aspects of its business. Quality is an integral part of the daily operation of all departments company wide. The Quality function assists in the facilitation of new concepts and ideas in the spirit of continuous improvement. And, to signify the importance at all levels of the

organization, the Quality Assurance Manager reports directly to the President and has the responsibility and authority in all matters affecting Quality and Reliability. Activities such as ISO9001 certification and dedication to QML are key indicators of our commitment to Quality and Continuous Improvement.





## QUALITY AND RELIABILITY

## CONTINUOUS QUALITY IMPROVEMENT INITIATIVE

In the spirit of maintaining an aggressive program of quality and reliability improvement, Linfinity has identified three customer-critical areas for focus.

→ Performance to Specification

→ Performance to Commitment
→ Customer Satisfaction

Each of these goals is described briefly below.

## ▶ Performance to Specification

Meeting published or implied specifications is absolutely critical to meeting company and customer expectations. Whether it is a process limit or final product specification limit, they are equally important in maintaining a high level of quality and consistency. Utilizing tools, such as Statistical Process Control (SPC) and Statistical Quality Control (SQC), enables measurable objectives and goals.

#### ▶ Performance to Commitment

Across all organizations, at all levels, extending to our distributors and customers, performance to commitment often is the measure of difference between success and failure. The rate at which our industry moves forward is unprecedented in history and being able to count on your suppliers is more important than ever. Not only is meeting delivery schedules important, but meeting product development, sampling, literature and a host of other events are of equal importance. The employees of Linfinity are striving to beat the commitment at all levels by knowing our performance in the past, measuring it in the present and continually improving our goals for the future.

#### ► Customer Satisfaction

There is one, bottom-line measurement of performance in this area. Our customer's requirements (internal or external) have been met or exceeded. When queried, our customers respond with a confident "Yes, I'm happy, satisfied and I'll be back to do business again!"

#### **KEY MEASUREMENT INDICES / PERFORMANCE CRITERIA**

#### **Product Qualification**

It is the intention of Linfinity to assure that each newly-designed device is thoroughly qualified prior to its production release. A formal routine of qualifying procedures are followed for each new device type. Included in this procedure is a reliability validation of the first three candidate lots according to the schedule in Table 1.

## **On-Going Product Reliability Monitors**

The Reliability Monitoring Program at Linfinity is intended to determine the continuing acceptability of the product line. This program includes both short-term and extended-range testing on key package and device performance indices. Periodic and regular sampling of current production by generic package and device types assures a constant affirmation of device reliability. See Table 2.

#### Table 1

#### PRODUCT QUALIFICATION SCHEDULE

TEST	CONDITIONS	SS/Acc No.
Autoclave	15 PSIG, 121°C, 96 Hours	50/0
Temperature Cycle	-65°C to +150°C, 100 Cycles	50 / 0
Operating Life Test	+125°C, 1000 Hours or equivalent	50/0
Thermal Shock	-55°C to +125°C, 100 Cycles	50/0
HAST (Biased)	+130°C, 85% RH, 100 Hours	50/0

#### Table 2

#### PRODUCT RELIABILITY MONITOR CONDITIONS

TEST		SS/Acc No.	MONITOR CONDITIONS	EXTENDED CONDITIONS
Autoclave	(15 PSIG)	50/0	96 Hours	168 Hours
Temperature Cycle	(-65°C to +150°C)	50/0	100 Cycles	1000 Cycles
Operating Life Test	(+125°C)	50/0	1000 Hours	2000 Hours
Thermal Shock	(-55°C to +125°C)	50/0	100 Cycles	1000 Cycles
HAST (Biased)	(+130°C)	50/0	100 Hours	300 Hours



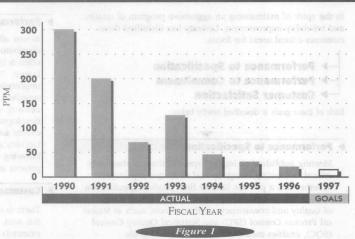
## Quality

## QUALITY AND RELIABILITY

KEY MEASUREMENT INDICES / PERFORMANCE CRITERIA

## **Outgoing Product Quality Levels**

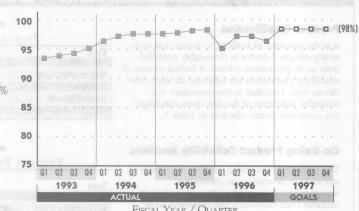
The Outgoing Quality level is monitored and computed by Quality Assurance on a scheduled basis. Each lot is sampled and inspected for conformance to specification. Only lots with zero defects in the sample are accepted. See Figure 1.



OUTGOING QUALITY HISTORY WITH PERFORMANCE GOALS (CALCULATED NUMBER OF DEFECTS IN PPM)

## **Performance To Schedule**

Critical to meeting our commitments, Performance-to-Schedule is an ideal index to measure our performance in our customer's eyes as well as to benchmark our competition. As can be seen by the numbers in Figure 2, we are performing at a very high level in a period of heavy market demand. And, as indicated by our goals for the future, we will continue to strive for 100% ontime delivery to our commitments.



FISCAL YEAR / QUARTER

ON-TIME DELIVERY -- PERFORMANCE TO SCHEDULE



## QUALITY AND RELIABILITY

#### INDUSTRY CERTIFICATION CREDENTIALS

Quality Assurance at Linfinity Microelectronics Inc. has been designed to be in conformance with several Military and Commercial grade quality and inspection system requirements. The Quality Assurance system has been certified by many OEM customers and Government Agencies to be in conformance with one or more of the following specifications:

## CERTIFICATION REQUIREMENT

ISO9001 (Quality System)

Self Qualification Status MIL-Q-9858A (Quality System) MIL-I-45208A (Inspection System) MIL-PRF-38535 (General Specification for QML Microcircuits) Standard Military Drawing Certification

#### **CERTIFYING AGENCY**

KEMA Registered Quality The Dutch Council For Certification (RvC) The Registrar Accreditation Board (RAB) The European Network For Quality System Assessment And Certification (EQNet) DELCO Elect., Kokomo, Indiana OEM Customers OEM Customers DESC-ELSC, Dayton, Ohio DESC-ELDS, Dayton, Ohio MIL-S-19500 (General Specification for QPL Semiconductor Devices) DESC-ELST, Dayton, Ohio

#### QUALITY AND RELIABILITY QUESTIONS

For any questions regarding Quality and Reliability, whether they may be about data, documentation, processing, or nonconforming products or services, use the following instructions.

- 1. Call 714-898-8121.
- 2. Indicate you have a question regarding Quality and Reliability.
- **3.** If it is product specific, please have the *device number*.
- 4. If it is documentation or test related, indicate you have a Documentation question.
- 5. The receptionist will forward you to the correct Q&R contact.



# Quality

## HIGH-RELIABILITY SCREENING PROCEDURES FOR LINEAR IC'S

#### LINEAR INTEGRATED CIRCUITS

Linfinity manufactures hermetic products to the three standard levels of quality assurance processing outlined below. In addition, the company's unique flexibility allows ready accommodations to special customer requirements. The following Class S and Class B screening procedures are in compliance with methods as detailed in MIL-STD-883.

Screen	Class S Method F	Reqm't.	Class B Method Reqm't.	Standard Product Method Reqm't	
Wafer Lot Acceptance	5007	Sample	N/A	N/A	
Non-Destructive Bond Pull	2023	100%	N/A	N/A	
Internal Visual (Pre-Cap)	2010, Condition A	100%	2010, Condition B 100%	Commercial Visual 100%	
Stabilization Bake	1008, Condition C 24 Hours @ 150°C	100%	1008, Condition C 100% 24 Hours @ 150°C	1008, Condition C Optiona 24 Hours @ 150°C	
Temperature Cycling	1010, Condition C 10 Cycles, -65°C to +150°C	100%	1010, Condition C 100% 10 Cycles, -65°C to +150°C	1010, Condition C Optiona 10 Cycles, -65°C to +150°C	
Constant Acceleration	2001, Applicable Condition per Package Type	100% e	2001, Applicable 100% Condition per Package Type	2001, Applicable Optiona Condition per Package Type	
Particle Impact Noise Detection (PIND)	2020, Condition A		N/A	N/A	
Hermeticity (Seal) a) Fine Leak b) Gross Leak	1014, Condition B 5 x 10 <sup>-8</sup> atm-cc/sec 1014, Condition C1	100%	1014, Condition B 100% 5 x 10 <sup>-8</sup> atm-cc/sec 1014, Condition C1 100%	1014, Condition B Sample 5 x 10 <sup>-8</sup> atm-cc/sec 1014, Condition C1 Sample	
Pre-Burn-in Electrical Test	Per Applicable Device Spec Unit Serialization as require		Per Applicable Device Spec.	Per Applicable Device Spec.	
Burn-in Test	1015, Dynamic 240 Hours @ 125°C Minimu (Note: An additional 72 Hrs HTRB burn-in and interim electrical test as required)	m	1015, Static or 100% Dynamic 160 Hours @ 125°C Minimum or equivalent	N/A	
Final Electrical Test a) DC @ 25°C b) DC @ Max. and Min. Rated Temp. c) Dynamic @ 25°C d) Functional @ 25°C	Per Applicable Device Spec	100% 100% 100% 100%	Per Applicable Device Spec. 100% 100% 100% 100%	Per Applicable Device Spec. 1009 Sampli 1009 1009	
Hermeticity (Seal) a) Fine Leak b) Gross Leak	1014, Condition B 5 x 10-8 atm-cc/sec 1014, Condition C1	100%	N/A N/A	N/A N/A	
Radiography	Method 2012	100%	N/A	N/A	
External Visual	Method 2009	100%	Method 2009 100%	Method 2009 100%	
<b>Quality Conformance Testing</b> Group A	5005 DC, AC Parameters	+25°C +125°C -55°C	5005 DC, AC Parameters +25°C +125°C -55°C		
Groups B, C (Class B only), D	5005 Paragraph	3.5	5005 Paragraph 3.5		



# JAN, JANTX & JANTXV SCREENING PROCEDURES FOR MIL-S-19500/474 DIODE ARRAYS

## MIL-S-19500/474 DIODE ARRAYS

Screen	Method - MIL-STD-750	Requirement	Comments
Internal Visual (Pre-Cap)	MIL-STD-883 Method 2010 Cond. B	JANTXV only	Specified in MIL-S-19500/474
Stabilization Bake	1032 24 Hours @ 200°C	100%	
Temperature Cycling	1051 20 Cycles, -65°C to +175°C	100%	
Constant Acceleration	2006 20,000 g, Y, orientation	100%	
Hermeticity (Seal) a) Fine Leak	1071	100%	
b) Gross Leak		100%	
Pre-Burn-in Electrical Test	Per Applicable Device Specification	100%	
Burn-in Test	1038 72 Hours @ 150°C	100%	As specified in MIL-S-19500/474
Final Electrical Test a) DC @ 25°C b) DC @ Max. and Min. Rated Temp. c) Delta Measurements	Per Applicable Device Specification	100% 100% 100%	
<b>Quality Conformance Testing</b> Group A	External Visual DC, AC Parameters	+25°C +150°C -55°C	Subgroup 1 Subgroups 2, 4, 6, 7 Subgroup 3 Subgroup 3
Groups B & C	Sample Testing		

# Notes



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## **Working With Linfinity**

#### **ACCESSING INFORMATION AT LINFINITY**

Timely access to information is critical to success in today's rapidly-evolving electronics marketplace. And knowing how to get information is as critical as the information itself. Linfinity understands this, and we are focused on ensuring access to all information no matter how trivial it may seem. Our information guidelines are set by you, our customers.

Each and every employee at Linfinity understands your importance to us and we pledge to make every effort, reasonable or unreasonable, to get you the information you need. This section describes the many Linfinity services available to you.

#### FIELD-BASED SERVICES

#### LOCAL REPRESENTATIVES

Starting the process, we have a world-class set of local representatives who are keenly aware of Linfinity's pledge to you. They are our local presence and provide service to meet your daily needs. They can assist in quotations, delivery, samples, technical literature and can act as liasons in scheduling and implementing customer-critical events. In support of our local representatives, the Linfinity Inside Sales team provides factory-based, realtime information and coordination of customer-critical activities such as corporate contracts, Electronic Data Interchange (EDI), and expedite and lead times. This strong combination of local and factory-based resources provides you with the industry-leading service and support that is critical to success in today's challenging markets. A complete geographical listing of our representative network is provided in Section 14. Some areas of the country are supported directly by Linfinity. If you are located in one of these areas, the information in Section 14 will provide you with the appropriate phone number

#### DISTRIBUTION

Linfinity also has extensive coverage through the distribution channel. Our distributors work closely with the factory and our representative network to ensure they provide adequate stocking of all Linfinity products which are critical to customers in the area. The distributor network can work closely with your company to ensure they provide adequate stocking levels for a diverse set of business conditions relieving you of the burdensome job of managing inventory. And of equal importance, our distributors carry or have near immediate access to small quantities of products in most temperature, grade and packaging options to support evaluation, prototyping or preproduction runs. Additionally, all distributors stock Linfinity literature, providing quick and easy access to this information. For a complete listing of our distribution network organized by geography see Section 14.

## FACTORY-BASED SERVICES

#### BUSINESS HOURS

Linfinity business hours are from 8:00 am to 5:00 pm Pacific Coast Time. We will make every effort to field all requests during the business day. If you call after hours, please leave a voice message and we will return your call the next business day.

## TECHNICAL DOCUMENTATION

One of the elements critical to a successful design experience with Linear components is a designer's ability to understand and comprehend all conditions (environmentally and electrically) that their circuit must operate under. Documentation provided by component vendors is critical in this process. Linfinity's goal is to provide the best in technical literature, both from an aesthetic and, most importantly, technical standpoint. We will make every effort to anticipate the most probable applications and the subsequent need for information both from a guaranteed and typical operating standpoint along with an explanation of how the product functions in actual applications. We'll even include handy hints to help communicate application details.

There are several ways to access Linfinity technical documentation. First, our local representatives and distributors stock all our documentation. Second, the Linfinity Information Network (LIN) provides 24-hour, online access to FAX data sheets. To read more about how to gain access to LIN and its usage, see Section 4 later in this book. Third, during business hours, you can call Linfinity directly using the following instructions.

714-898-8121

Tech. Documentation Line

#### When using the Documentation line:

- Identify your call as a Technical Documentation request.
- 2. The receptionist will forward your call appropriately.



## FACTORY-BASED SERVICES (cont'd.) APPLICATION INFORMATION

If you have a question regarding the use of our products in your application, we will be happy to assist you. Our staff of experienced applications engineers are very familiar with the product line as well as many of the common and not so common applications for them. But oftentimes, it is very difficult to visualize a customer's specific application via a phone conversation and as such we recommend faxing even the simplest application schematics prior to your call. This will ensure that we interpret your questions accurately and provide the most expedient, technically correct answer possible. However, we also understand that some questions can be answered with a simple phone call. We will make every attempt to be available to answer your calls or to call you back within the hour. Use the following information when you need applications assistance.

714-372-3566 Application Info. Line

#### When using the Application FAX line:

- 1. Clearly label your FAX with the words: Application Ouestion.
- 2. Clearly label your FAX with the words: Part Number (e.g., LX1562).
- 3. Include a schematic with highlighted problem area along with a written description. Label all significant nodes with corresponding electrical conditions.
- 4. Be sure to provide your name, voice phone number and company name.

## VOICE

714-898-8121

Application Info. Line

#### When using the Application Voice line:

- 1. Identify your call as an Application Question.
- 2. Provide the product part number (e.g., LX1562).
- 3. Indicate if you have pre-sent a FAX.
- 4. The receptionist will forward your call to the appropriate Applications Engineer.

## FACTORY-BASED SERVICES (cont'd.) TECHNICAL PRODUCT INFORMATION

In addition to the specific application of products, there are product-specific questions. Examples include, certain parametric and functional performance attributes, test conditions, extraneous operating conditions, unspecified parameters or simple product quirks. These types of questions are best answered by the engineer (product, test, or design) who works with the product on a daily basis.

We are happy to make these people available to get you the answer as quickly as possible. Just like the applications assistance above, we suggest you use the following procedure to speed you through the Linfinity system. We suggest faxing your questions ahead of your call to ensure we have a clear understanding of your specific request.

714-372-3566

Product Info. Line

#### When using the Product FAX line:

- 1. Clearly label your FAX with the words: Product Question.
- 2. Clearly label your FAX with the words: Part Number (e.g., LX1562).
- 3. Include a written description, highlighting the problem area. Label all significant nodes with corresponding electrical conditions.
- 4. Be sure to provide your name, voice phone number and company name.

## VOICE

714-898-8121

Product Info. Line

#### When using the Application Voice line:

- 1. Identify your call as a Product Question.
- 2. Provide the product Part Number (e.g., LX1562).
- 3. Indicate if you have pre-sent a FAX.
- 4. The receptionist will forward your call to the appropriate Engineer.



# **Working With Linfinity**

# FACTORY-BASED SERVICES (cont'd.) FUTURE PRODUCT PLANS OR OFFERINGS

Linfinity has on-going product development activities in the Power Supply, Signal Conditioning and Data Communication product areas. Because we are a market-driven company, we are continuously searching for new ideas and better ways to service these markets. We encourage you to call us with product requirements you have identified as critical to your success. We will discuss our plans with you to see if our plans match your needs. We pledge to evaluate and respond to your requirements. Who knows, your product may be just around the corner!

## If you have a question about our Future Products:

- 1. Call 714-898-8121.
- 2. Tell the receptionist that you have a question about Future Products.
- **3.** The receptionist will forward you to the appropriate Marketing Engineer.

#### QUALITY AND RELIABILITY INFORMATION

Linfinity has instituted a program of Continuous Quality Improvement in all aspects of our business. Quality is an integral part of the daily operation of all departments company wide and not just the sole responsibility of the Quality department. The Quality function assists in facilitating new concepts and ideas within the company, while also acting as a clearing house and focal point for customer-critical inquiries. Section 2 is devoted solely to the explanation of Quality and Reliability at Linfinity. If you have questions relating to Quality and Reliability, simply refer to Section 2 for specific directions.

# FACTORY BASED SERVICES (cont'd.) COMPLAINTS, COMPLIMENTS OR OUTSTANDING ISSUES

Understandably, there will be issues which require our attention. We want to resolve those issues quickly to your absolute satisfaction. If the regular channels don't work, please use your judgement in contacting the appropriate functional area and responsible Vice President.

# Functional Areas

- → Development
- → Manufacturing
- → Marketing
- -> Sales In www.savewell .eldierog reward to

For all complaints, compliments and outstanding issues:

- 1. Call 714-898-8121.
- Tell the receptionist that you have a Development, Manufacturing, Marketing, or Sales Issue that you need to speak to someone about.
- 3. Be prepared with your company name and location.
- 4. The receptionist will forward your call appropriately.

## ALL OTHER QUESTIONS

If after reviewing this information, you still aren't sure who to ask for or what to do, simply follow these instructions.

#### For all other questions:

- 1. Call 714-898-8121.
- 2. Tell the receptionist that you have a General Question.
- 3. Be prepared with your company name and location.
- 4. The receptionist will forward your call appropriately.



4

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## Linfinity Information Network

INTRO TO THE LINFINITY INFORMATION NETWORK

## INTRODUCTION

To provide our customers with the highest level of service possible, Linfinity has implemented the Linfinity Information Network (LIN). The LIN network provides 24-hour a day, 7-day a week, worldwide access to product documentation, instantly eliminating the age old problems of conflicting time zones and work schedules. Not only do our customers have instant access to existing product documentation, they are first in line for available documentation on newly released products. In

addition, all documents are electronically generated and stored on the LIN network, providing the highest quality image available for FAX systems. No more blurred or illegible documents.

It is our intention to provide fast, accurate, easy access to critical documentation giving our customers that competitive edge in the ever quickening race to market. Read on to find out how to enroll in LIN and how to use it to your competitive advantage.



Fill out the reply card.



Drop it in a mailbox.

#### HOW TO ENROLL

There are two ways to gain access to LIN:

1. Simply fill out the attached business reply card and drop it off at your nearest post office

.. OR ..

2. Call 714-898-8121 and ask to be enrolled in the Linfinity Information Network. -

The receptionist will forward you to the responsible data-entry person. Be prepared to provide demographic information such as name, address, city, state, company name, and voice/fax phone numbers.

Whether you use the reply card or the phone-in method, you will be assigned an ACCESS code allowing use of the system. Within two working days of receipt of your application, we will send you a personalized -ACCESS CARD that can be carried in your wallet or stored in your business card file. If at any time you lose the card or simply don't have it readily available, simply call the number above and we can provide your ACCESS number once you have provided the proper identification.



Call in.

Within a few working days.





## **Linfinity Information Network**

INTRO TO THE LINFINITY INFORMATION NETWORK

#### HOW TO USE THE LINFINITY INFORMATION

Simply call (714) 372-3848, any time of the day, any day of the week, from your FAX machine. The only prerequisites are an ACCESS number and a Document #.

## DON'T FORGET THAT YOU MUST CALL FROM A FAX MACHINE IN ORDER TO RECEIVE THE REQUESTED DOCUMENT.

Enter your ACCESS number found on the front of your access card. Document numbers can be found in this catalog in two locations. First, in the Selection Guides (sections 6 through 10), each device type has a table labeled LIN Document #'s. In the table there are Full and Summary numbers. Full is a FAX document that represents a comprehensive, all inclusive data sheet that can have a significant number of pages. Summary is a FAX document that represents a condensed and consolidated version of the full data sheet that will typically have less than three pages. See the example below.

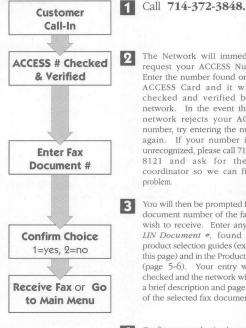
#### **Example Fax Document # Table** ocated in Selection Guides & Index

LIN Document # 15402 1540

A second location where document numbers can be found is in the Procuct Index on page 5-6.

The Product Index provides a comprehensive list of documents by device type. Once you are ready with your ACCESS and Document numbers, call the system and it will begin prompting you for information. For additional information, a flow chart and specific instructions are listed on the right side of this page.

#### SPECIFIC OPERATING INSTRUCTIONS



The Network will immediately request your ACCESS Number. Enter the number found on your

ACCESS Card and it will be checked and verified by the network. In the event that the network rejects your ACCESS number, try entering the number again. If your number is still unrecognized, please call 714-898-8121 and ask for the LIN coordinator so we can fix the problem.

- You will then be prompted for the document number of the fax you wish to receive. Enter any valid LIN Document #, found in all product selection guides (example this page) and in the Product Index (page 5-6). Your entry will be checked and the network will give a brief description and page count of the selected fax document.
- Confirm your selection by pressing '1' for yes, or cancel your request by pressing '2' for no.
- Finally, you will be given the option of receiving your fax document by pressing the pound '#' key, or returning to the main menu by pressing '1'. By returning to the main menu, you can select additional fax documents, for a total of three documents per call.

For a Current Product Index, Request Document # 1000 For a Current New Products Update List, Request Document # 1001

#### THE FUTURE OF THE LINFINITY INFORMATION NETWORK

Our goal is to be able to provide our customers with fast and easy access to information at Linfinity. The LIN network's first task is product data sheets but the future holds other capabilities as well. Access to other technical literature and documentation in addition to fulfillment activities for promotional programs are in the works. The pace of our industry is quickening at every corner and we fully intend to set the pace for the future. If you have any suggestions, questions or problems regarding the Network, please contact us at this number 714-898-8121 and ask for the LIN coordinator.



## SHOPE WILL TENENDED THE ZER OF WORL

Simply rall (714) 372-5848, any time of the day, any day of the week, from your RAX machine. The only prerequisites are an ACCRSS number and a Document e

# DON'T FORGET THAT YOU MUST CALL FROM A FAX MACHINE NU ORDER TO RECEME THE REQUESTED DOCUMENT

Enter your ALKESS number found on the front of your access card. Document numbers can be found in the eating to two locations. End, in the Sciention Guides receiues o through 10), each device type has a table labeled IIV Increment #X 10), in the table laber are full and Sammary numbers. But is a LAX document that represents a compenhensive, will inclusive district the can have a supplificant number to proges.

Sentrary is a LAX document that represents a condensed and created that whence the a condensed and consolidated version of the full data sheet that will to piculiy have less than three pages. See the example below.

# Mary yearnes (SCI) Apprint of the policy of

A second from an where document aunitors can be found as in the Proxuct index on page 5-6.

The Praduct Index provides a comprehensive his of documents by device type. Once year are ready with your ACCESS and Document atmbers, call (lie system and Keell) begin proposing you for information. For eligibous information, a flow that and specific inserticions are listed on the debt and other or this require.

## setomer SS Call 714-Call-In

The Network will immediately request your ACCESS Number. Enter the number found on your ACCESS Card and it will be ACCESS Card and it will be network in the event that the network rejects your ACCESS and your reading the number again. If your number is still unrecipited please cut Ti4898 unrecipited please cut Ti4898 and ask for the LIN reconference so we can fix the

You will then be prompted for the document, member or the fax you will no receive. Enter my wild the LLV Document - found in all produces selection guides testing by produce selection guides testing this page) and in the Product Index (page 5-6). Your entry will be checked and the network will give a brief everlation and page count.

Confirm your selection by pressing 'I' for yes, or cannet your request by conscious 'I' fee you

Finally, you will be given the operand of necessing the pound document by pressing the pound mean by pressing 1'. By returning to the main mean, you can elect metal fax documents, for a real of these documents and of these documents are and of these documents are all the all these documents are all the all th

For a Council Product Index, Request Discountry 1000.

Our goal is to be able to previde our engages with law and easy access to information at Linformy. The LFF retworks firm use is product data sheets but the future holds other capabilities as well access to other reclaimed foresame and documentation in addition to individue for promotional programs are in the weeks. The pace of our industry is quickwing at early counce, and we fully intend to set the pace for the future. If you have any suggestions, questions an problems regarding tire. Network please contact us at this number 714-898-8171 and ask-for the 11st documentaries.



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## PRODUCT SELECTION BY FUNCTION

POWER SUPPLY CIRCUITS			POWER SU	PPLY CIRCUITS (co	(cont'd.)	
PWM IC	Controllers		PWM IC Co	entrollers (continued)		
LX1552	Ultra-Low Start-Up Current, Current Mode PWM	5-15	UC3843A	Current Mode PWM Controller	6-357	
LX1553	Ultra-Low Start-Up Current, Current Mode PWM	5-15	UC3844A	Current Mode PWM Controller	6-357	
LX1554	Ultra-Low Start-Up Current, Current Mode PWM	5-15	UC3845A	Current Mode PWM Controller	6-357	
LX1555	Ultra-Low Start-Up Current, Current Mode PWM	5-15				
LX1562	Second-Generation Power Factor Controller	5-33	Low Dropo	ut Positive Voltage Regulators		
LX1563	Second-Generation Power Factor Controller	5-33	*LX8020	Ultra-Low Dropout Regulator (ULDO™)	6.00	
*LX1570	Phase Mod. AC Synch. SecSide Controller	5-59	*LX8020A	Ultra-Low Dropout Regulator (ULDO <sup>TM</sup> )		
*LX1571	Phase Mod. AC Synch. SecSide Controller	5-59	*LX8020-28	Ultra-Low Dropout Regulator (ULDO <sup>TM</sup> )		
LX1823	High-Speed Current Mode PWM	5-71	*LX8020A-28	Ultra-Low Dropout Regulator (ULDO <sup>TM</sup> )		
SG1524	Voltage Mode Pulse Width Modulator 6-	239	*LX8020-30	Ultra-Low Dropout Regulator (ULDO <sup>TM</sup> )		
SG1524B	Voltage Mode Pulse Width Modulator 6-	241	*LX8020A-30	Ultra-Low Dropout Regulator (ULDO <sup>TM</sup> )		
SG1525A	Voltage Mode Pulse Width Modulator 6-	243	*LX8020-33	Ultra-Low Dropout Regulator (ULDO <sup>TM</sup> )		
SG1526	Voltage Mode Pulse Width Modulator 6-	245	*LX8020A-33	Ultra-Low Dropout Regulator (ULDOTM)		
SG1526B	Voltage Mode Pulse Width Modulator 6-	247	*LX8020-48	Ultra-Low Dropout Regulator (ULDO*)		
SG1527A	Voltage Mode Pulse Width Modulator 6-	243	*LX8020A-48	Ultra-Low Dropout Regulator (ULDO <sup>TM</sup> )		
SG1529	Voltage Mode Pulse Width Modulator 6-	249	*LX8020-50	Ultra-Low Dropout Regulator (ULDOTM)		
SG1825C	High-Speed Current Mode PWM 6-	267	*LX8020A-50	Ultra-Low Dropout Regulator (ULDO™)		
SG1842	Current Mode Pulse Width Modulator 6-	275	*LX8383	7.5A LDO Positive Adj. Regulator		
SG1843	Current Mode Pulse Width Modulator 6-	275	*LX8383A	7.5A LDO Positive Adj. Regulator		
SG1844	Current Mode Pulse Width Modulator 6-	289	LX8384	5A LDO Positive Adj. Regulator		
SG1845	Current Mode Pulse Width Modulator 6-	289	LX8384A	5A LDO Positive Adj. Regulator		
SG1846	Current Mode Pulse Width Modulator 6-	301	LX8385	3A LDO Positive Adj. Regulator		
SG2524	Voltage Mode Pulse Width Modulator 6-	239	LX8386	1.5A LDO Positive Adj. Regulator		
SG2524B	Voltage Mode Pulse Width Modulator 6-	241	*LX8554	5A Extremely LDO Positive Adj. Regulator		
SG2525A	Voltage Mode Pulse Width Modulator 6-	243	*LX8582A	8.5A LDO Positive Adj. Regulator		
SG2526	Voltage Mode Pulse Width Modulator 6-	245	*LX8584	7A LDO Positive Adj. Regulator		
SG2526B	Voltage Mode Pulse Width Modulator 6-	247	*LX8584A	7A LDO Positive Adj. Regulator		
SG2527A	Voltage Mode Pulse Width Modulator 6-	243	*LX8584B	7A LDO Positive Adj. Regulator		
SG2529	Voltage Mode Pulse Width Modulator 6-	249	LX8585	4.6A LDO Positive Adj. Regulator		
SG2825C	High-Speed Current Mode PWM 6-	267	LX8585A	4.6A LDO Positive Adj. Regulator		
SG2842	Current Mode Pulse Width Modulator6-	275	*LX8586	6A LDO Positive Adj. Regulator		
SG2843	Current Mode Pulse Width Modulator 6-		*LX8586A	6A LDO Positive Adj. Regulator		
SG2844	Current Mode Pulse Width Modulator 6-		*LX8587	3A LDO Positive Adj. Regulator		
SG2845	Current Mode Pulse Width Modulator 6-	289	*LX8587A	3A LDO Positive Adj. Regulator		
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Manufacturer Part #	Product Description	Linfinity Part #	Comments / Differences / Linfinity Improved Alternate
Alpha	<b>的人们以来是一些有效对对人的关系,但是有关的对人的</b>		
AS2815	1.5A Low Dropout Positive Adjustable Regulator	LX8386	7812A 78002 7800
AS2830	3A Low Dropout Positive Adjustable Regulator	LX8385	LX8385-33 Fixed 3.3V Version
AS2850	5A Low Dropout Positive Adjustable Regulator	LX8384	LX8384-33 Fixed 3.3V Version
Cherry	EDVNER STREET BEEN BUILDING STREET		
CH1526	Dual Output Regulating PWM	SG1526	Direct Replacement
CH 1524	Dual Output Regulating PWM	SG1524	Direct Replacement
CH1524A	Improved Dual Output Regulating PWM, 1%V <sub>REF</sub>	SG1524B	Direct Replacement
CH1525A	Improved Dual Output Regulating PWM, 1%V <sub>REF</sub>	SG1525A	Direct Replacement
CS1527A	Improved Dual Output Regulating PWM, 1%V <sub>REF</sub>	SG1527A	Direct Replacement
CS1842	Current Mode PWM	SG1842	Direct Replacement
CS1843	Current Mode PWM	SG1843	Direct Replacement
CS2524	Dual output Regulating PWM	SG2524	Direct Replacement
CS2524A	Improved Dual Output Regulating PWM, 1%V <sub>REF</sub>	SG2524B	Direct Replacement
CS2525A	Improved Dual Output Regulating PWM, 1%VREF	SG2525A	Direct Replacement
CS2526	Dual Output Regulating PWM	SG2526	Direct Replacement
CS2527A	Improved Dual Output Regulating PWM, 1%V <sub>REF</sub>	SG2527A	Direct Replacement
CS2842A	Current Mode PWM (ind temp)	SG2842	Direct Replacement
CS2843A	Current Mode PWM (ind temp)	SG2843	Direct Replacement
CS2844	Current Mode PWM (ind temp)	SG2844	Direct Replacement
CS2845	Current Mode PWM (ind temp)	SG2845	Direct Replacement
CS3524	Dual Output Regulating PWM	SG3524	Direct Replacement
CS3524A	Improved Dual Output Regulating PWM, 1%Vpss	SG3524B	Direct Replacement
CS3842A	Current Mode PWM (comm temp)	SG3842	Direct Replacement
CS3843A	Current Mode PWM (comm temp)	SG3843	Direct Replacement
CS3844	Current Mode PWM (comm temp)	SG3844	Direct Replacement
CS3845	Current Mode PWM (comm temp)	SG3845	Direct Replacement
Dallas Semicon			
DS21S07	SCSI Active Terminator, 9 Channel	LX5107	page than acade
Fairchild / Natio	nal		
UA109	Positive Fixed Voltage Regulator, 5V	SG109	Direct Replacement
UA117	Positive Adjustable Voltage Regulator	SG117	Direct Replacement
UA1524	Dual Output Regulating PWM	SG1524	Direct Replacement
UA209	Positive Fixed Voltag Regulator, 5V	SG209	Direct Replacement
UA2524	Dual Output Regulating PWM	SG2524	Direct Replacement
UA309	Positive Fixed Voltage Regulator, 5V	SG309	Direct Replacement
UA317	Positive Adjustable Voltage Regulator	SG317	Direct Replacement
UA3524	Dual Output Regulating PWM	SG3524	Direct Replacement
UA55450	Dual Peripheral Positive AND Driver	SG55450B	Direct Replacement
UA55452	Dual Peripheral NAND Driver	SG55452B	Direct Replacement
UA55462	Dual Peripheral NAND Driver	SG55462	Direct Replacement
UA75450	Dual Peripheral Positive AND Driver	SG75450B	Direct Replacement
UA75451	Dual Peripheral Positive AND Driver	SG75451B	Direct Replacement
UA75452	Dual Peripheral NAND Driver	SG75452B	Direct Replacement
UA75453	Dual Peripheral OR Driver	SG75453B	Direct Replacement
UA75461	Dual Peripheral Positive AND Driver	SG75461	Direct Replacement



Manufacturer Part #	Product Description	Linfinity Part #	Comments / Differences / Linfinity Improved Alternate
Fairchild / Natio	nal (continued)		
UA75462	Dual Peripheral NAND Driver	SG75462	Direct Replacement
UA7805-M	Positive Fixed Voltage Regulator, 5V	SG7805	Direct Replacement
UA7806-M	Positive Fixed Voltage Regulator, 6V	SG7806	Direct Replacement
UA7808-M	Positive Fixed Voltage Regulator, 8V	SG7808	Direct Replacement
UA7812-M	Positive Fixed Voltage Regulator, 12V	SG7812	Direct Replacement
UA7815-M	Positive Fixed Voltage Regulator, 15V	SG7815	Direct Replacement
UA7820-M	Positive Fixed Voltage Regulator, 20V	SG7820	Direct Replacement
UA7824-M	Positive Fixed Voltage Regulator, 24V	SG7824	Direct Replacement
UA7905-M	Negative Fixed Voltage Regulator, 5V	SG7905	Direct Replacement
UA7908-M	Negative Fixed Voltage Regulator, 8V	SG7908	Direct Replacement
UA7912-M	Negative Fixed Voltage Regulator, 12V	SG7912	Direct Replacement
UA7915-M	Negative Fixed Voltage Regulator, 15V	SG7915	Direct Replacement
UA9665	Medium Current Driver Array, V <sub>CF</sub> = 50V, I <sub>OUT</sub> = 0.5A	SG2001	Direct Replacement
UA9666	Medium Current Driver Array, V <sub>CE</sub> = 50V, I <sub>OUT</sub> = 0.5A	SG2002	Direct Replacement
UA9667	Medium Current Driver Array, V <sub>CE</sub> = 50V, I <sub>OUT</sub> = 0.5A	SG2003	Direct Replacement
Linear Technolo	17 65 7 001		
LM117	Positive Adjustable Voltage Regulator	SG117	Direct Replacement
LM117A	Positive Adj. Voltage Regulator - High Performance	SG117A	Direct Replacement
LM137	Negative Adjustable Voltage Regulator	SG137	Direct Replacement
LM317	Positive Adjustable Voltage Regulator	SG317	Direct Replacement
LM317A	Positive Adj. Voltage Regulator - High Performance	SG317A	Direct Replacement
LM337	Negative Adjustable Voltage Regulator	SG337	Direct Replacement
LT1083	7.5A Low Dropout Positive Adjustable Regulator	LX8383	Direct Replace. / Lower Supply Voltage
LT1084	5A Low Dropout Positive Adjustable Regulator	LX8384	Direct Replace. / Lower Supply Voltage
LT1085	3A Low Dropout Positive Adjustable Regulator	LX8385	Direct Replace. / Lower Supply Voltage
LT1086	1.5A Low Dropout Positive Adjustable Regulator	LX8386	Direct Replace. / Lower Supply Voltage
LT1242	Low Start-Up Current, Current Mode PWM	LX1552	Different Pinout / No C.S. Blanking
LT1243	Low Start-Up Current, Current Mode PWM	LX1553	Different Pinout / No C.S. Blanking
LT1244	Low Start-Up Current, Current Mode PWM	LX1554	Different Pinout / No C.S. Blanking
LT1245	Low Start-Up Current, Current Mode PWM	LX1555	Different Pinout / No C.S. Blanking
LT137A	Negative Adj. Voltage Regulator - High Performance	SG137A	Direct Replacement
LT1431	Adjustable Shunt Reference (0.4%)	LX1431	Different Pinout / LX6431B available
LT1524	Dual Output Regulating PWM	SG1524	Direct Replacement
LT1525A	Improved Dual Output Regulating PWM, 1% Vppp	SG1525A	Direct Replacement
LT1526	Dual Output Regulating PWM	SG1526	Direct Replacement
LT1527A	Improved Dual Output Regulating PWM, 1% V	SG1527A	Direct Replacement
LT1584	7A Low Dropout Positive Adjustable Regulator	LX8584	Direct Replacement
LT1585	4A Low Dropout Positive Adjustable Regulator	LX8585	Direct Replacement
LT1587	3A Low Dropout Positive Adjustable Regulator	LX8587	Direct Replacement
LT1842	Current Mode PWM	SG1842	Direct Replacement
LT1843		SG1843	Direct Replacement
LT2524	Dual Output Regulating PWM	SG2524	Direct Replacement
LT2524A	Improved Dual Output Regulating PWM, 1% V <sub>PFF</sub>	SG2524B	Direct Replacement
LT2524A	Dual Output Regulating PWM	SG2526	Direct Replacement
12020	Negative Adj. Voltage Regulator - High Performance	SG337A	Direct Replacement



Manufacturer Part #	Product Description	Linfinity Part #	Comments / Differences / Linfinity Improved Alternate
Linear Tech (conti	inued)		NAME OF THE OWNER OF THE OWNER OF THE OWNER.
T3524	Dual Output Regulating PWM	SG3524	Direct Replacement
T3525A	Improved Dual Output Regulating PWM, 1% V	SG3525A	Direct Replacement
T3526	Dual Output Regulating PWM	SG3526	Direct Replacement
T3527	Improved Dual Output Regulating PWM, 1% V	SG3527A	Direct Replacement
G1524	Dual Output Regulating PWM	SG1524	Direct Replacement
G1525A	Improved Dual Output Regulating PWM, 1% VREF	SG1525A	Direct Replacement
G1527A	Improved Dual Output Regulating PWM, 1% V	SG1527A	Direct Replacement
SG2524	Dual Output Regulating PWM	SG2524	Direct Replacement
G3524	Dual Output Regulating PWM	SG3524	Direct Replacement
G3525A	Improved Dual Output Regulating PWM, 1% V	SG3525A	Direct Replacement
SG3527A	Improved Dual Output Regulating PWM, 1% V	SG3527A	Direct Replacement
JC1846	Current Mode PWM	SG1846	Direct Replacement
JC3846	Current Mode PWM	SG3846	Direct Replacement
Motorola	· 网络外属从在1965年的 1985年 1886年 1985年		
-M109	Positive Fixed Voltage Regulator, 5V	SG109	Direct Replacement
M117	Positive Adjustable Voltage Regulator	SG117	Direct Replacement
M137	Negative Adjustable Voltage Regulator	SG137	Direct Replacement
M140-12	Positive Fixed Voltage Regulator, 12V	SG140-12	Direct Replacement
M140-15	Positive Fixed Voltage Regulator, 15V	SG140-15	Direct Replacement
M140-18	Positive Fixed Voltage Regulator, 18V	SG140-18	Direct Replacement
M140-24	Positive Fixed Voltage Regulator, 24V	SG140-24	Direct Replacement
M209	Positive Fixed Voltage Regulator, 5V	SG209	Direct Replacement
M217	Positive Adjustable Voltage Regulator	SG217	Direct Replacement
M237	Negative Adjustable Voltage Regulator	SG237	Direct Replacement
M309	Positive Fixed Voltage Regulator, 5V	SG309	Direct Replacement
M317	Positive Adjustable Voltage Regulator	SG317	Direct Replacement
M337	Negative Adjustable Voltage Regulator	SG337	Direct Replacement
MAD1103F	16 Diode Array	SG5772F	Direct Replacement
MAD1104F	4 Common Anode, 4 Common Cathode Diode Array	SG5774F	Direct Replacement
MAD1108C	8 Straight Thru Diodes	SG6101J	Direct Replacement
MC1403	Precision 2.5V Reference	SG3503	Direct Replacement
MC1411	Medium Current Driver Array, V <sub>CE</sub> = 50V, I <sub>OUT</sub> = 0.5A	SG2001	Direct Replacement
MC1412	Medium Current Driver Array, V <sub>CE</sub> = 50V, I <sub>OUT</sub> = 0.5A	SG2002	Direct Replacement
AC1413	Medium Current Driver Array, V <sub>CE</sub> = 50V, I <sub>OUT</sub> = 0.5A	SG2003	Direct Replacement
MC1416	Medium Current Driver Array, V <sub>CE</sub> = 50V, I <sub>OUT</sub> = 0.5A	SG2004	Direct Replacement
AC1436	High Voltage Operational Amplifier	SG1436	Direct Replacement
AC1503	Precision 2.5V Reference	SG1503	Direct Replacement
MC1536	High Voltage Operational Amplifier	SG1536	Direct Replacement
AC1723	Positive Adjustable Voltage Regulator	SG723	Direct Replacement
AC33064x-5	5V Undervoltage Sensing Circuit (ind. temp.)	MC33064	Direct Replacement / LX70011 avail.
AC33164x-3	3V Undervoltage Sensing Circuit (ind. temp.)	MC33164-3	Direct Replacement
AC33164x-5	5V Undervoltage Sensing Circuit (ind. temp)	SG33164	Direct Replacement
AC34064x-5	5V Undervoltage Sensing Circuit (comm. temp.)	MC34064	Direct Replacement / LX7001C avail
AC34164x-3	3V Undervoltage Sensing Circuit (comm. temp.)	MC34164-3	Direct Replacement
MC34164x-5	5V Undervoltage Sensing Circuit (comm. temp.)	SG34164	Direct Replacement



Manufacturer Part #	Product Description	Linfinity Part #	Comments / Differences / Linfinity Improved Alternate
Motorola (continu	ed)	THE REAL PROPERTY.	
AC7805	Positive Fixed Voltage Regulator, 5V	SG7805	Direct Replacement
AC7805A	Positive Fixed Voltage Regulator, 5V	SG7805A	Direct Replacement
AC7806	Positive Fixed Voltage Regulator, 6V	SG7806	Direct Replacement
AC7806A	Positive Fixed Voltage Regulator, 6V	SG7806A	Direct Replacement
AC7808	Positive Fixed Voltage Regulator, 8V	SG7808	Direct Replacement
AC7808A	Positive Fixed Voltage Regulator, 8V	SG7808A	Direct Replacement
AC7812	Positive Fixed Voltage Regulator, 12V	SG7812	Direct Replacement
AC7812A	Positive Fixed Voltage Regulator, 12V	SG7812A	Direct Replacement
AC7815	Positive Fixed Voltage Regulator, 15V	SG7815	Direct Replacement
AC7815A	Positive Fixed Voltage Regulator, 15V	SG7815A	Direct Replacement
AC7820	Positive Fixed Voltage Regulator, 20V	SG7820	Direct Replacement
AC7820A	Positive Fixed Voltage Regulator, 20V	SG7820A	Direct Replacement
AC7824	Positive Fixed Voltage Regulator, 24V	SG7824	Direct Replacement
AC7824A	Positive Fixed Voltage Regulator, 24V	SG7824A	Direct Replacement
AC7905	Negative Fixed Voltage Regulator, 5V	SG7905	Direct Replacement
AC7905A	Negative Fixed Voltage Regulator, 5V	SG7905A	Direct Replacement
AC7905.2	Negative Fixed Voltage Regulator, 5.2V	SG7905.2	Direct Replacement
AC7905.2A	Negative Fixed Voltage Regulator, 5.2V	SG7905.2A	Direct Replacement
AC7908	Negative Fixed Voltage Regulator, 8V	SG7908	Direct Replacement
AC7908A	Negative Fixed Voltage Regulator, 8V	SG7908A	Direct Replacement
AC7912	Negative Fixed Voltage Regulator, 12V	SG7912	Direct Replacement
AC7912A	Negative Fixed Voltage Regulator, 12V	SG7912A	Direct Replacement
AC7915	Negative Fixed Voltage Regulator, 15V	SG7915	Direct Replacement
AC7915A	Negative Fixed Voltage Regulator, 15V	SG7915A	Direct Replacement
AC7918	Negative Fixed Voltage Regulator, 18V	SG7918	Direct Replacement
AC7918A	Negative Fixed Voltage Regulator, 18V	SG7918A	Direct Replacement
AC7920	Negative Fixed Voltage Regulator, 20V	SG7920	Direct Replacement
AC7920A	Negative Fixed Voltage Regulator, 20V	SG7920A	Direct Replacement
G1525A	Improved Dual Output Regulating PWM, 1% VREF	SG1525A	Direct Replacement
G1526	Dual Output Regulating PWM	SG1526	Direct Replacement
G1527A	Improved Dual Output Regulating PWM, 1% VREF	SG1527A	Direct Replacement
G2525A	Improved Dual Output Regulating PWM, 1% VREF	SG2525A	Direct Replacement
G2526	Dual Output Regulating PWM	SG2526	Direct Replacement
G2527A	Improved Dual Output Regulating PWM, 1% V <sub>REF</sub>	SG2527A	Direct Replacement
G3525A	Improved Dual Output Regulating PWM, 1% V <sub>REF</sub>	SG3525A	Direct Replacement
G3526	Dual Output Regulating PWM	SG3526	Direct Replacement
L431	Adjustable Shunt Reference (2%)	TL431	Direct Replacement / LX6431 avail.
L431A	Adjustable Shunt Reference (1%)	TL431A	Direct Replacement / LX6431A avail
L431B	Adjustable Shunt Reference (1%)	TL431A	Direct Replacement / LX6431A avail
JC2842A	Current Mode PWM (ind. temp.)	SG2842	Direct Replacement
JC2842B	Current Mode PWM (ind. temp.)	UC2842A	Direct Replacement / LX1552I avail.
JC2843A	Current Mode PWM (ind. temp.)	SG2843	Direct Replacement
JC2843B	Current Mode PWM (ind. temp.)	UC2843A	Direct Replacement / LX1553I avail.
JC2844A	Current Mode PWM (ind. temp.)	SG2844	Direct Replacement
JC2844B	Current Mode PWM (ind. temp.)	UC2844A	Direct Replacement / LX1554I avail.



Manufacturer	Product	Linfinity	Comments / Differences /
Part #	Description	Part #	Linfinity Improved Alternate
Motorola (continu			
UC2845A	Current Mode PWM (ind. temp.)	SG2845	Direct Replacement
UC2845B	Current Mode PWM (ind. temp.)	UC2845A	Direct Replacement / LX1555I avail.
UC3842A	Current Mode PWM (comm. temp.)	SG3842	Direct Replacement
UC3842B	Current Mode PWM (comm. temp.)	UC3842A	Direct Replacement / LX1552C avail
UC3843A	Current Mode PWM (comm. temp.)	SG3843	Direct Replacement
UC3843B	Current Mode PWM (comm. temp.)	UC3843A	Direct Replacement / LX1553C avail
UC3844A	Current Mode PWM (comm. temp.)	SG3844	Direct Replacement
UC3844B	Current Mode PWM (comm. temp.)	UC3844A	Direct Replacement / LX1554C avail
UC3845A	Current Mode PWM (comm. temp.)	SG3845	Direct Replacement
UC3845B	Current Mode PWM (comm. temp.)	UC3845A	Direct Replacement / LX1555C avail
National			
DS55325	Dual Source / Dual Sink Memory Driver	SG55325	Direct Replacement
DS55451	Dual Peripheral Positive AND Driver	SG55451	Direct Replacement
DS55452	Dual Peripheral NAND Driver	SG55452	Direct Replacement
DS55454	Dual Peripheral OR Driver	SG55454	Direct Replacement
DS55461	Dual Peripheral Positive AND Driver	SG55451	Direct Replacement
DS55462	Dual Peripheral NAND Driver	SG55462	Direct Replacement
DS55463	Dual Peripheral OR Driver	SG55463	Direct Replacement
DS55464	Dual Peripheral NOR Driver	SG55464	Direct Replacement
DS55470	Dual Peripheral Positive AND Driver	SG55470	Direct Replacement
DS55471	Dual Peripheral Positive AND Driver	SG55471	Direct Replacement
FSA2002M	8 Common Cathode Diode Array	SG5768F	Direct Replacement
FSA2003M	8 Common Anode Diode Array	SG5770F	Direct Replacement
FSA2500M	16 Diode Array	SG5772F	Direct Replacement
FSA2719M	8 Straight Thru Diodes	SG6101J	Direct Replacement
FSA2721M	7 Straight Thru Diodes	SG6100F	Direct Replacement
LM103-3.0	Voltage Reference, 3.0V	SG103-3.0	Direct Replacement
LM103-3.3	Voltage Reference, 3.3V	SG103-3.3	Direct Replacement
M103-3.6	Voltage Reference, 3.6V	SG103-3.6	Direct Replacement
LM103-3.9	Voltage Reference, 3.9V	SG103-3.9	Direct Replacement
LM109	Positive Fixed Voltage Regulator, 5V	SG109	Direct Replacement
LM117	Positive Adjustable Voltage Regulator	SG117	Direct Replacement
LM120-05	Negative Fixed Voltage Regulator, 5V	SG120-05	Direct Replacement
M120-08	Negative Fixed Voltage Regulator, 8V	SG120-08	Direct Replacement
LM120-12	Negative Fixed Voltage Regulator, 12V	SG120-12	Direct Replacement
LM120-15	Negative Fixed Voltage Regulator, 15V	SG120-15	Direct Replacement
LM120-18	Negative Fixed Voltage Regulator, 18V	SG120-18	Direct Replacement
LM120-20	Negative Fixed Voltage Regulator, 20V	SG120-20	Direct Replacement
M120-5.2	Negative Fixed Voltage Regulator, 5.2V	SG120-5.2	Direct Replacement
M137	Negative Adjustable Voltage Regulator	SG137	Direct Replacement
M140-05	Positive Fixed Voltage Regulator, 5V	SG140-05	Direct Replacement
M140-06	Positive Fixed Voltage Regulator, 6V	SG140-06	Direct Replacement
M140-08	Positive Fixed Voltage Regulator, 8V	SG140-08	Direct Replacement
M140-12	Positive Fixed Voltage Regulator, 12V	SG140-12	Direct Replacement
M140-12	Positive Fixed Voltage Regulator, 12V	SG140-12 SG140-15	Direct Replacement
LM140-15	Positive Fixed Voltage Regulator, 15V	SG140-15 SG140-18	Direct Replacement



Manufacturer Part #	Product Description	Linfinity Part #	Comments / Differences / Linfinity Improved Alternate
National (continue	d)		
M140-20	Positive Fixed Voltage Regulator, 20V	SG140-20	Direct Replacement
M143	High-Voltage Operational Amplifier	SG143	Direct Replacement
M1524	Dual Output Regulating PWM	SG1524	Direct Replacement
M209	Positive Fixed Voltage Regulator, 5V	SG209	Direct Replacement
M217	Positive Adjustable Voltage Regulator	SG217	Direct Replacement
M237	Negative Adjustable Voltage Regulator	SG237	Direct Replacement
M2524	Dual Output Regulating PWM	SG2524	Direct Replacement
M2935	Dual Low Dropout Regulator	SG29055	Direct Replacement
M2985	Dual Low Dropout Regulator	SG29085	Direct Replacement
M309	Positive Fixed Voltage Regulator, 5V	SG309	Direct Replacement
M317	Positive Adjustable Voltage Regulator	SG317	Direct Replacement
M337	Negative Adjustable Voltage Regulator	SG337	Direct Replacement
M3524	Dual Output Regulating PWM	SG3524	Direct Replacement
M431A	Adjustable Shunt Reference (2%)	TL431	Direct Replacement / LX6431 avail
M723	Positive Adjustable Voltage Regulator	SG723	Direct Replacement
AAD1105	8 Common Cathode Diode Array	SG5768	Direct Replacement
AAD1106	8 Common Anode Diode Array	SG5770	Direct Replacement
AAD1107	4 Common Anode, 4 Common Cathode Diode Array	SG5774	Direct Replacement
AAD1109	7 Straight Thru Diodes	SG6100	Direct Replacement
IA109	Positive Fixed Voltage Regulator, 5V	SG109	Direct Replacement
JA117	Positive Adjustable Voltage Regulator	SG117	Direct Replacement
JA1524	Dual Output Regulating PWM	SG1524	Direct Replacement
JA2524	Dual Output Regulating PWM	SG2524	Direct Replacement
JA309	Positive Fixed Voltage Regulator, 5V	SG309	Direct Replacement
JA317	Positive Adjustable Voltage Regulator	SG317	Direct Replacement
JA3524	Dual Output Regulating PWM	SG3524	Direct Replacement
A55450	Dual Peripheral Positive AND Driver	SG55450B	Direct Replacement
A55452	Dual Peripheral NAND Driver	SG55452B	Direct Replacement
A55462	Dual Peripheral NAND Driver	SG55462	Direct Replacement
A75450	Dual Peripheral Positive AND Driver	SG75450B	Direct Replacement
A75451	Dual Peripheral Positive AND Driver	SG75451B	Direct Replacement
A75452	Dual Peripheral NAND Driver	SG75452B	Direct Replacement
A75453	Dual Peripheral OR Driver	SG75453B	Direct Replacement
A75461	Dual Peripheral Positive AND Driver	SG75461	Direct Replacement
A75462	Dual Peripheral NAND Driver	SG75462	Direct Replacement
IA7805-M	Positive Fixed Voltage Regulator, 5V	SG7805	Direct Replacement
A7806-M	Positive Fixed Voltage Regulator, 6V	SG7806	Direct Replacement
A7808-M	Positive Fixed Voltage Regulator, 8V	SG7808	Direct Replacement
A7812-M	Positive Fixed Voltage Regulator, 12V	SG7812	Direct Replacement
A7815-M	Positive Fixed Voltage Regulator, 15V	SG7815	Direct Replacement
A7820-M	Positive Fixed Voltage Regulator, 20V	SG7820	Direct Replacement
A7824-M	Positive Fixed Voltage Regulator, 24V	SG7824	Direct Replacement
A7905-M	Negative Fixed Voltage Regulator, 5V	SG7905	Direct Replacement
A7908-M	Negative Fixed Voltage Regulator, 8V	SG7908	Direct Replacement
JA7912-M	Negative Fixed Voltage Regulator, 12V	SG7912	Direct Replacement
JA7915-M	Negative Fixed Voltage Regulator, 15V	SG7915	Direct Replacement



BEING STEELS AND STEELS	CROSS REFERENCE GUIDE (continued)						
Manufacturer Part #	Product Description	Linfinity Part #	Comments / Differences / Linfinity Improved Alternate				
National (continue							
UA9665	Medium Current Driver Array, V <sub>CE</sub> = 50V, I <sub>OUT</sub> = 0.5A	SG2001	Direct Replacement				
UA9666	Medium Current Driver Array, V <sub>CE</sub> = 50V, I <sub>OUT</sub> = 0.5A	SG2002	Direct Replacement				
UA9667	Medium Current Driver Array, V <sub>CE</sub> = 50V, I <sub>OUT</sub> = 0.5A	SG2003	Direct Replacement				
1N5768	8 Common Cathode Diode Array	1N5768	Direct Replacement				
1N5770	8 Common Anode Diode Array	1N5770	Direct Replacement				
1N5772	16 Diode Array	1N5772	Direct Replacement				
Semtech			<b>电影的数据显示图图图图图图图图图图图图图图图图图图图图图图图图图图图图图图图图图图图图</b>				
EZ1083A	7.5A Low Dropout Positive Adjustable Regulator	LX8383A	8 JUDICUST WOLLEUG				
EZ1584	7A Low Dropout Positive Adjustable Regulator	LX8584	ST SECTIONS WOULDEDG TO CORNER				
EZ1584A	7A Low Dropout Positive Adjustable Regulator	LX8584A	MBDV User own Esq.				
EZ1585	4.6A Low Dropout Positive Adjustable Regulator	LX8585	SV SIGROLIDA MILADI				
EZ1585A	4.6A Low Dropout Positive Adjustable Regulator	LX8585A	NOR AUTOMACANA				
EZ1587	3A Low Dropout Positive Adjustable Regulator	LX8587	TENESE TURBU BUU				
EZ1587A	3A Low Dropout Positive Adjustable Regulator	LX8587A	est regine esperantos Artesa				
SC1083	7.5A Low Dropout Positive Adjustable Regulator	LX8383	Minor Elec'l. Diff. / Dropout V, VINMA				
SC1084	5A Low Dropout Positive Adjustable Regulator	LX8384	Minor Elec'l. Diff. / Dropout V, VINMA				
SC1085	3A Low Dropout Positive Adjustable Regulator	LX8385	Minor Elec'l. Diff. / Dropout V, VINMA				
SC1086	1.5A Low Dropout Positive Adjustable Regulator	LX8386	Minor Elec'l. Diff. / Dropout V, VIN MA				
SGS	D. I.B. C. Li. Li. III						
L272	Dual Power Operational Amplifier	SG3272	Direct Replacement				
L2722 L2726	Dual Power Operational Amplifier	SG3272	Direct Replacement Direct Replacement				
	Dual Power Operational Amplifier	SG3272					
L601	Medium Current Driver Array, V <sub>CE</sub> = 95V, I <sub>OUT</sub> = 0.5A	SG2821	Direct Replacement				
L602	Medium Current Driver Array, V <sub>CE</sub> = 95V, I <sub>OUT</sub> = 0.5A	SG2822	Direct Replacement				
L603	Medium Current Driver Array, V <sub>CE</sub> = 95V, I <sub>OUT</sub> = 0.5A	SG2823	Direct Replacement				
L604 L7805	Medium Current Driver Array, V <sub>CE</sub> = 95V, I <sub>OUT</sub> = 0.5A	SG2824	Direct Replacement				
L7806	Positive Fixed Voltage Regulator, 5V	SG7805	Direct Replacement				
L7808	Positive Fixed Voltage Regulator, 6V	SG7806	Direct Replacement				
	Positive Fixed Voltage Regulator, 8V	SG7808	Dir det itopiacoment				
L7812	Positive Fixed Voltage Regulator, 12V	SG7812	Direct Replacement				
L7815	Positive Fixed Voltage Regulator, 15V	SG7815	Direct Replacement				
L7820	Positive Fixed Voltage Regulator, 20V	SG7820	Direct Replacement				
L7824	Positive Fixed Voltage Regulator, 24V	SG7824	Direct Replacement				
L7905	Negative Fixed Voltage Regulator, 5V	SG7905	Direct Replacement				
L7905.2	Negative Fixed Voltage Regulator, 5.2V	SG7905.2	Direct Replacement				
L7908	Negative Fixed Voltage Regulator, 8V	SG7908	Direct Replacement				
L7912	Negative Fixed Voltage Regulator, 12V	SG7912	Direct Replacement				
L7915	Negative Fixed Voltage Regulator, 15V	SG7915	Direct Replacement				
L7918	Negative Fixed Voltage Regulator, 18V	SG7918	Direct Replacement				
L7920	Negative Fixed Voltage Regulator, 20V	SG7920	Direct Replacement				
LM217	Positive Adjustable Voltage Regulator	SG217	Direct Replacement				
LM317	Positive Adjustable Voltage Regulator	SG317	Direct Replacement				
LM723	Positive Adjustable Voltage Regulator	SG723	Direct Replacement				
ULN2801A	Medium Current Driver Array, $V_{CE} = 50V$ , $I_{OUT} = 0.5A$	SG2801	Direct Replacement				
ULN2802A	Medium Current Driver Array, V <sub>CE</sub> = 50V, I <sub>OUT</sub> = 0.5A	SG2802	Direct Replacement				
ULN2803A	Medium Current Driver Array, $V_{CE} = 50V$ , $I_{OUT} = 0.5A$	SG2803	Direct Replacement				
ULN2804A	Medium Current Driver Array, V <sub>CE</sub> = 50V, I <sub>OUT</sub> = 0.5A	SG2804	Direct Replacement				



Manufacturer	Product	Linfinity	Comments / Differences /
Part #	Description	Part #	Linfinity Improved Alternate
Sprague / Allegr			
UDN2935	Half-Bridge Driver	SG3635	Direct Replacement
ULN8125A	Improved Dual Output Regulating PWM, 1% V <sub>REF</sub>	SG3525A	Direct Replacement
ULN8126	Dual Output Regulating PWM	SG3526	Direct Replacement
ULN8127A	Improved Dual Output Regulating PWM, 1% V <sub>REF</sub>	SG3527A	Direct Replacement
ULQ8124	Dual Output Regulating PWM	SG2524	Direct Replacement
ULQ8125	Improved Dual Output Regulating PWM, 1% V <sub>REF</sub>	SG2525A	Direct Replacement
ULQ8126	Dual Output Regulating PWM	SG2526	Direct Replacement
ULQ8127	Improved Dual Output Regulating PWM, 1% V <sub>REF</sub>	SG2527A	Direct Replacement
ULS2001	Medium Current Driver Array, V <sub>CE</sub> = 50V, I <sub>OUT</sub> = 0.5A	SG2001	Direct Replacement
ULS2002	Medium Current Driver Array, V <sub>CE</sub> = 50V, I <sub>OUT</sub> = 0.5A	SG2002	Direct Replacement
ULS2003	Medium Current Driver Array, $V_{CE} = 50V$ , $I_{OUT} = 0.5A$	SG2003	Direct Replacement
ULS2004	Medium Current Driver Array, V <sub>CE</sub> = 50V, I <sub>OUT</sub> = 0.5A	SG2004	Direct Replacement
ULS2011	Medium Current Driver Array, V <sub>CE</sub> = 50V, I <sub>OUT</sub> = 0.6A	SG2011	Direct Replacement
ULS2012	Medium Current Driver Array, V <sub>CE</sub> = 50V, I <sub>OUT</sub> = 0.6A	SG2012	Direct Replacement
ULS2013	Medium Current Driver Array, $V_{CE} = 50V$ , $I_{OUT} = 0.6A$	SG2013	Direct Replacement
ULS2014	Medium Current Driver Array, V <sub>CE</sub> = 50V, I <sub>OUT</sub> = 0.6A	SG2014	Direct Replacement
ULS2021	Medium Current Driver Array, V <sub>CE</sub> = 95V, I <sub>OUT</sub> = 0.5A	SG2021	Direct Replacement
ULS2022	Medium Current Driver Array, V <sub>CE</sub> = 95V, I <sub>OUT</sub> = 0.5A	SG2022	Direct Replacement
ULS2023	Medium Current Driver Array, V <sub>CE</sub> = 95V, I <sub>OUT</sub> = 0.5A	SG2023	Direct Replacement
ULS2024	Medium Current Driver Array, V <sub>CE</sub> = 95V, I <sub>OUT</sub> = 0.5A	SG2024	Direct Replacement
ULS2801	Medium Current Driver Array, V <sub>CE</sub> = 50V, I <sub>OUT</sub> = 0.5A	SG2801	Direct Replacement
ULS2802	Medium Current Driver Array, V <sub>CE</sub> = 50V, I <sub>OUT</sub> = 0.5A	SG2802	Direct Replacement
ULS2803	Medium Current Driver Array, V <sub>CF</sub> = 50V, I <sub>OUT</sub> = 0.5A	SG2803	Direct Replacement
ULS2804	Medium Current Driver Array, V <sub>CF</sub> = 50V, I <sub>OUT</sub> = 0.5A	SG2804	Direct Replacement
ULS2811	Medium Current Driver Array, V <sub>CE</sub> = 50V, I <sub>OUT</sub> = 0.6A	SG2811	Direct Replacement
ULS2812	Medium Current Driver Array, V <sub>CE</sub> = 50V, I <sub>OUT</sub> = 0.6A	SG2812	Direct Replacement
ULS2813	Medium Current Driver Array, V <sub>CE</sub> = 50V, I <sub>OUT</sub> = 0.6A	SG2813	Direct Replacement
ULS2814	Medium Current Driver Array, $V_{cr} = 50V$ , $I_{cur} = 0.6A$	SG2814	Direct Replacement
ULS2821	Medium Current Driver Array, V <sub>CE</sub> = 95V, I <sub>OUT</sub> = 0.5A	SG2821	Direct Replacement
ULS2822	Medium Current Driver Array, V <sub>CE</sub> = 95V, I <sub>OUT</sub> = 0.5A	SG2822	Direct Replacement
ULS2823	Medium Current Driver Array, V <sub>CE</sub> = 95V, I <sub>OUT</sub> = 0.5A	SG2823	Direct Replacement
ULS2824	Medium Current Driver Array, V <sub>CE</sub> = 95V, I <sub>OUT</sub> = 0.5A	SG2824	Direct Replacement
ULS8124	Dual Output Regulating PWM	SG1524	Direct Replacement
ULS8125A	Improved Dual Output Regulating PWM, 1% V	SG1525A	Direct Replacement
ULS8126H	Dual Output Regulating PWM	SG1526	Direct Replacement
ULS8127A	Improved Dual Output Regulating PWM, 1% V <sub>RFF</sub>	SG1527A	Direct Replacement
Texas Instrumen		3013217	Direct Replacement
LM137	Negative Adjustable Voltage Regulator	SG137	Direct Replacement
LM217	Positive Adjustable Voltage Regulator	SG217	Direct Replacement
LM237	Negative Adjustable Voltage Regulator	SG237	Direct Replacement
SG1524	Dual Output Regulating PWM	SG1524	Direct Replacement
SG2524	Dual Output Regulating PWM	SG2524	Direct Replacement
SN75325	Dual Source / Dual Sink Memory Driver	SG75325	Direct Replacement
SN75325	Quad Sink Memory Driver	SG75325	Direct Replacement
SN75327	Quad Source Memory Driver	SG75326 SG75327	Direct Replacement
	Gudu Jource Mellioly Dilvel	30/332/	DIFECT KEDIACEITIETT
SN75450B	Dual Peripheral Positive AND Driver	SG75450B	Direct Replacement



Manufacturer Part #	Product Description	Linfinity Part #	Comments / Differences / Linfinity Improved Alternate		
Texas Instrumen	ts (continued)				
SN75452B	Dual Peripheral NAND Driver	SG75452B	Direct Replacement		
SN75453B	Dual Peripheral OR Driver	SG75453B	Direct Replacement		
SN75454B	Dual Peripheral NOR Driver	SG75454B	Direct Replacement		
SN75460	Dual Peripheral Positive AND Driver	SG75460	Direct Replacement		
SN75461	Dual Peripheral Positive AND Driver	SG75461	Direct Replacement		
SN75462	Dual Peripheral NAND Driver	SG75462	Direct Replacement		
SN75463	Dual Peripheral OR Driver	SG75463	Direct Replacement		
SN75464	Dual Peripheral NOR Driver	SG75464	Direct Replacement		
SN75470	Dual Peripheral Positive AND Driver	SG75470	Direct Replacement		
SN75471	Dual Peripheral Positive AND Driver	SG75471	Direct Replacement		
SN75472	Dual Peripheral NAND Driver	SG75472	Direct Replacement		
SN75473	Dual Peripheral OR Driver	SG75473	Direct Replacement		
SN75474	Dual Peripheral NOR Driver	SG75474	Direct Replacement		
SNJ55325	Dual Source / Dual Sink Memory Driver	SG55325	Direct Replacement		
SNJ55326	Quad Sink Memory Driver	SG55326	Direct Replacement		
SNJ55450B	Dual Peripheral Positive AND Driver	SG55450B	Direct Replacement		
SNJ55451B	Dual Peripheral Positive AND Driver	SG55451B	Direct Replacement		
SNJ55452B	Dual Peripheral NAND Driver	SG55452B	Direct Replacement		
SNJ55453B	Dual Peripheral OR Driver	SG55453B	Direct Replacement		
SNJ55454B	Dual Periperal NOR Driver	SG55454B	Direct Replacement		
SNJ55460	Dual Peripheral Positive AND Driver	SG55460	Direct Replacement		
SNJ55461	Dual Peripheral Positive AND Driver	SG554612	Direct Replacement		
SNJ55462	Dual Peripheral NAND Driver	SG55462	Direct Replacement		
SNJ55463	Dual Peripheral OR Driver	SG55463	Direct Replacement		
SNJ55464	Dual Peripheral NOR Driver	SG55464	Direct Replacement		
SNJ55470	Dual Peripheral Positive AND Driver	SG55470	Direct Replacement		
SNJ55471	Dual Peripheral Positive AND Driver	SG55471	Direct Replacement		
SNJ55472	Dual Peripheral NAND Driver	SG55472	Direct Replacement		
SNJ55473	Dual Peripheral OR Driver	SG55473	Direct Replacement		
SNJ55474	Dual Peripheral NOR Driver	SG55474	Direct Replacement		
ΓL117	Positive Adjustable Voltage Regulator	SG117	Direct Replacement		
ΓL1525A	Improved Dual Output Regulating PWM, 1% VREF	SG1525A	Direct Replacement		
ΓL1527A	Improved Dual Output Regulating PWM, 1% VREE	SG1527A	Direct Replacement		
TL2218-285	SCSI Active Terminator, 9-Channel	LX5219	Direct Replacement / Improved ICC		
TL2525A	Improved Dual Output Regulating PWM, 1% VREF	SG2525A	Direct Replacement		
TL2527A	Improved Dual Output Regulating PWM, 1% VREF	SG2527A	Direct Replacement		
ΓL1431	Adjustable Shunt Reference (0.4%)	TL431B	Direct Replacement / LX6431B avail		
ΓL431	Adjustable Shunt Reference (2%)	TL431	Direct Replacement / LX6431 avail.		
TL431A	Adjustable Shunt Reference (1%)	TL431A	Direct Replacement / LX6431A avail		



Manufacturer Part #	Product Description	Linfinity Part #	Comments / Differences / Linfinity Improved Alternate
Unitrode		STATE OF THE PARTY	
PIC600	Switching Regulator Power Output Stages	SM600	Direct Replacement
PIC601	Switching Regulator Power Output Stages	SM601	Direct Replacement
PIC602	Switching Regulator Power Output Stages	SM602	Direct Replacement
PIC610	Switching Regulator Power Output Stages	SM610	Direct Replacement
PIC611	Switching Regulator Power Output Stages	SM611	Direct Replacement
PIC612	Switching Regulator Power Output Stages	SM612	Direct Replacement
PIC625	Switching Regulator Power Output Stages	SM625	Direct Replacement
PIC626	Switching Regulator Power Output Stages	SM626	Direct Replacement
PIC627	Switching Regulator Power Output Stages	SM627	Direct Replacement
PIC645	Switching Regulator Power Output Stages	SM645	Direct Replacement
PIC646	Switching Regulator Power Output Stages	SM646	Direct Replacement
PIC647	Switching Regulator Power Output Stages	SM647	Direct Replacement
JC117	Positive Adjustable Voltage Regulator	SG117	Direct Replacement
JC120-05	Negative Fixed Voltage Regulator, 5V	SG120-05	Direct Replacement
JC120-12	Negative Fixed Voltage Regulator, 12V	SG120-12	Direct Replacement
JC120-15	Negative Fixed Voltage Regulator, 15V	SG120-15	Direct Replacement
JC137	Negative Adjustable Voltage Regulator	SG137	Direct Replacement
JC140-05	Positive Fixed Voltage Regulator, 5V	SG140-05	Direct Replacement
JC140-12	Positive Fixed Voltage Regulator, 12V	SG140-12	Direct Replacement
JC140-15	Positive Fixed Voltage Regulator, 15V	SG140-15	Direct Replacement
JC1524	Dual Output Regulating PWM	SG1524	Direct Replacement
JC1524A	Improved Dual Output Regulating PWM, 1% Vppp	SG1524B	Direct Replacement
JC1525A	Improved Dual Output Regulating PWM, 1% V <sub>RFF</sub>	SG1525A	Direct Replacement
JC1526	Dual Output Regulating PWM	SG1526	Direct Replacement
JC1526A	Improved Dual Output Regulating PWM	SG1526B	Direct Replacement
JC1527A	Improved Dual Output Regulating PWM, 1% VRFF	SG1527A	Direct Replacement
JC1543	Precision Power Supply Output Supervisory Circuit	SG1543	Direct Replacement
JC1544	Precision Power Supply Output Supervisory Circuit	SG1544	Direct Replacement
JC1823	High Speed, Current Mode PWM	LX1823	Minor Elec'l. Differences / Frequenc
JC1842	Current Mode PWM (mil. temp.)	SG1842	Direct Replacement
JC1842A	Current Mode PWM (mil. temp.)	UC1842A	Direct Replacement
JC1843	Current Mode PWM (mil. temp.)	SG1843	Direct Replacement
JC1843A	Current Mode PWM (mil. temp.)	UC1843A	Direct Replacement
JC1844	Current Mode PWM (mil. temp.)	SG1844	Direct Replacement
JC1844A	Current Mode PWM (mil. temp.)	UC1844A	Direct Replacement
JC1845	Current Mode PWM (mil. temp.)	SG1845	Direct Replacement
JC1845A	Current Mode PWM (mil. temp.)	UC1845A	Direct Replacement
JC1846	Current Mode PWM (mil. temp.)	SG1846	Direct Replacement
JC217	Positive Adjustable Voltage Regulator	SG217	Direct Replacement
JC237	Negative Adjustable Voltage Regulator	SG237	Direct Replacement
JC2524	Dual Output Regulating PWM	SG2524	Direct Replacement
JC2524A	Improved Dual Output Regulating PWM, 1% V <sub>REF</sub>	SG2524B	Direct Replacement
JC2525A	Improved Dual Output Regulating PWM, 1% V <sub>REF</sub>	SG2525A	Direct Replacement
JC2526	Dual Output Regulating PWM	SG2526	Direct Replacement
JC2526A	Improved Dual Output Regulating PWM	SG2526B	Direct Replacement
JC2527A	Improved Dual Output Regulating PWM, 1% VREF	SG2527A	Direct Replacement



Direct Replacement   Direct	Manufacturer Part #	Product Description	Linfinity Part #	Comments / Differences / Linfinity Improved Alternate
UC2844   Precision Power Supply Output Supervisory Circuit   SG2544   Precision Power Supply Output Supervisory Circuit   SG2544   Precision Power Supply Output Supervisory Circuit   SG2844   Direct Replacement   UC28492   Current Mode PWM (ind. temp.)   UC28492   UC28492   UC28492   Ucrent Mode PWM (ind. temp.)   UC28493   UC2843A   Direct Replacement   UC28493   UC2843A   Current Mode PWM (ind. temp.)   UC28493   UC28493   Direct Replacement   UC28493   UC28493   UC28493   UC28494   UC28	Unitrode (continue	ed)		
Direct Replacement   Direct	JC2540	Off Line Start Up Controller With SCR Driver	SG2540	Direct Replacement
Common	JC2543	Precision Power Supply Output Supervisory Circuit	SG2543	Direct Replacement
C2842A   Current Mode PWM (Ind. temp.)   C2842A   Direct Replacement	JC2544	Precision Power Supply Output Supervisory Circuit	SG2544	Direct Replacement
Common   C	JC2842	Current Mode PWM (ind. temp.)	SG2842	Direct Replacement
C2843A   Current Mode PWM (ind. temp.)   UC2843A   Direct Replacement	JC2842A	Current Mode PWM (ind. temp.)	UC2842A	Direct Replacement
Common   C	JC2843	Current Mode PWM (ind. temp.)	SG2843	Direct Replacement
Comment   Comm	JC2843A	Current Mode PWM (ind. temp.)	UC2843A	Direct Replacement
Comment Mode PWM (ind. temp.)   SG2845   Direct Replacement	JC2844	Current Mode PWM (ind. temp.)	SG2844	Direct Replacement
Comment   Comm	JC2844A	Current Mode PWM (ind. temp.)	UC2844A	Direct Replacement
Carrent Mode PWM (ind. temp.)   SG2846   Direct Replacement	JC2845	Current Mode PWM (ind. temp.)	SG2845	Direct Replacement
Positive Adjustable Voltage Regulator   SG317   Direct Replacement	JC2845A	Current Mode PWM (ind. temp.)	UC2845A	Direct Replacement
Negative Adjustable Voltage Regulator  C3337  Negative Adjustable Voltage Regulator  C3524  Dual Output Regulating PWM  C3525A  Improved Dual Output Regulating PWM  C3526A  Dual Output Regulating PWM  C3526A  Improved Dual Output Regulating PWM  C3527A  Improved Dual Output Regulating PWM, 1% V SG3526B  C3527A  Improved Dual Output Regulating PWM, 1% V SG3526B  C3527A  Improved Dual Output Regulating PWM, 1% V SG3527A  Direct Replacement  D163544  Precision Power Supply Output Supervisory Circuit  C3544  Precision Power Supply Output Supervisory Circuit  C3544  Precision Power Supply Output Supervisory Circuit  C3544  Current Mode PWM (comm. temp.)  C3842  Current Mode PWM (comm. temp.)  C3843  Current Mode PWM (comm. temp.)  C3844A  Current Mode PWM (comm. temp.)  C3845A  Current Mode PWM (comm. temp.)  C3846A  Current Mode PWM (comm. temp.)  C3845B  Current Mode PWM (comm. temp.)  C3846A  Current Mode PWM (comm. temp.)  C3847A  Direct Replacement  Di	JC2846	Current Mode PWM (ind. temp.)	SG2846	Direct Replacement
Dual Output Regulating PWM INC3524   Direct Replacement Direct Replace	JC317	Positive Adjustable Voltage Regulator	SG317	Direct Replacement
Improved Dual Output Regulating PWM, 1% V REF SG3525A Direct Replacement Dual Cu3526A Unproved Dual Output Regulating PWM SG3526B Direct Replacement Dual Cu3526A Improved Dual Output Regulating PWM SG3526B Direct Replacement Dual Cu3527A Improved Dual Output Regulating PWM, 1% VREF SG3527A Direct Replacement Dual Cu3527A Improved Dual Output Regulating PWM, 1% VREF SG3527A Direct Replacement Dual Cu3527A Improved Dual Output Supervisory Circuit SG3524B Direct Replacement Dual Cu3527A Direct Replacement Du	JC337	Negative Adjustable Voltage Regulator	SG337	Direct Replacement
Dual Output Regulating PWM  IC3526A Improved Dual Output Regulating PWM  IC3527A Improved Dual Output Regulating PWM, 1% V REF  IC3527A Improved Dual Output Regulating PWM, 1% V REF  IC3527A Improved Dual Output Regulating PWM, 1% V REF  IC3527A Improved Dual Output Regulating PWM, 1% V REF  IC3527A Improved Dual Output Regulating PWM, 1% V REF  IC3527A Improved Dual Output Regulating PWM, 1% V REF  IC3527A Improved Dual Output Regulating PWM, 1% V REF  IC3527A Improved Dual Output Regulating PWM, 1% V REF  IC3527A Improved Dual Output Regulating PWM, 1% V REF  IC3527A Direct Replacement  Direct Rep	JC3524	Dual Output Regulating PWM	SG3524	Direct Replacement
Improved Dual Output Regulating PWM IC3527A Improved Dual Output Regulating PWM, 1% VRET IC363544 Improved Dual Output Regulating PWM, 1% VRET IC363444 Improved Dual Output Regulating PWM, 1% VRET IC3642 Improved Dual Output Regulating PWM, 1% VRET IC3643 Improved Dual Output Regulating PWM, 1% VRET IC3644 Improved Direct Replacement Ic3645 Improved Output Regulating PWM, 1% VRET Improved Ic3644 Improved Output Regulating PWM, 1% VRET IC3645 Improved Output Regulating PWM, 1% VRET IC3646 Improved Output Regulating PWM, 1% VRET IC3647 Improved Output Regulating PWM, 1% VRET IC3646 IC3	JC3525A	Improved Dual Output Regulating PWM, 1% VREF	SG3525A	Direct Replacement
Improved Dual Output Regulating PWM, 1% V REF SG3597A  Improved Dual Output Regulating PWM, 1% V REF SG3543  Precision Power Supply Output Supervisory Circuit SG3544  Precision Power Supply Output Supervisory Circuit SG3544  Direct Replacement Direct Replacement SG3717  Stepper Motor Driver Supply Output Supervisory Circuit SG3544  Direct Replacement Direct Replacement SG3717  Stepper Motor Driver SG3718  Direct Replacement Direct Replacement SG3717  Stepper Motor Driver SG3842  Current Mode PWM (comm. temp.)  IC3842A  Current Mode PWM (comm. temp.)  IC3843A  Current Mode PWM (comm. temp.)  IC3844A  Current Mode PWM (comm. temp.)  IC3844A  Current Mode PWM (comm. temp.)  IC3845A  Current Mode PWM (comm. temp.)  IC3846  Current Mode PWM (comm. temp.)  IC3846  Current Mode PWM (comm. temp.)  IC3846  IC3846  Current Mode PWM (comm. temp.)  IC5601  SCSI Active Terminator, 18-Channel  IC5602  SCSI Active Terminator, 18-Channel  IC5603  SCSI Active Terminator, 18-Channel  IC5604  SCSI Active Terminator, 18-Channel  IC5605  SCSI Active Terminator, 18-Channel  IC5606  SCSI Active Terminator, 18-Channel  IC5607  SCSI Active Terminator, 18-Channel  IC5608  SCSI Active Terminator, 18-Channel  IC5609  SCSI Active Terminator, 9-Channel  IC5601  SCSI Active Terminator, 9-Channel  IC5602  SCSI Active Terminator, 9-Channel  IC5603  SCSI Active Terminator, 9-Channel  IC5604  SCSI Active Terminator, 9-Channel  IC5605  SCSI Active Ter	JC3526	Dual Output Regulating PWM	SG3526	Direct Replacement
Precision Power Supply Output Supervisory Circuit SG3544 Precision Power Supply Output Supervisory Circuit Precision Power Supply Output Supervisory Circuit SG3718 Direct Replacement / Improved Direct Replacement Direct Repla	JC3526A	Improved Dual Output Regulating PWM	SG3526B	Direct Replacement
Precision Power Supply Output Supervisory Circuit SG3544 Precision Power Supply Output Supervisory Circuit SG3717 Stepper Motor Driver SG3718 Direct Replacement / Improved Direct Replacement /	JC3527A	Improved Dual Output Regulating PWM, 1% VREF	SG3527A	Direct Replacement
Stapper Motor Driver   SG3718   Direct Replacement	JC3543	Precision Power Supply Output Supervisory Circuit	SG3543	Direct Replacement
Current Mode PWM (comm. temp.)  UC3842A  Current Mode PWM (comm. temp.)  UC3843A  Current Mode PWM (comm. temp.)  UC3844A  UC3844A  Current Mode PWM (comm. temp.)  UC3844A  UC3844A  Current Mode PWM (comm. temp.)  UC3845A  Current Mode PWM (comm. temp.)  UC3845A  Current Mode PWM (comm. temp.)  UC3845A  UC3845A  UC3845A  Current Mode PWM (comm. temp.)  UC3845A  UC3845A  UC3845A  UC3845A  UC3845A  UC3845A  UC3845A  UC3845A  Direct Replacement  UC3845A  Direct Replacement / Improved  UC5602  UC5603  SCSI Active Terminator, 18-Channel  UX5208  Direct Replacement / Improved  UC5609  SCSI Active Terminator, 18-Channel  UX5208  Direct Replacement / Improved  UC5610  SCSI Active Terminator, 18-Channel  UX5207  SCSI Active Terminator, 9-Channel  UX5207  SCSI Active Terminator, 9-Channel  UX5212  UC7805A  Positive Fixed Voltage Regulator, 5V  SG7805A  Positive Fixed Voltage Regulator, 5V  SG7805A  Positive Fixed Voltage Regulator, 12V  SG7812A  Direct Replacement  Direct Replacement  Direct Replacement  Direct Replacement / Improved  Direct Replacement / Improved  UC5805  Direct Replacement / Improved  UC5806  Direct Replacement / Improved  UC5807  Direct Replacement / Improved  UC5808  Direct Replacement / Improved  UC5809  Direct Replacement  UC5809  Direct Rep	JC3544	Precision Power Supply Output Supervisory Circuit	SG3544	Direct Replacement
Current Mode PWM (comm. temp.)  Current Mode PWM (comm. temp.)	JC3717	Stepper Motor Driver	SG3718	Direct Replacement
Current Mode PWM (comm. temp.)  Current Mode PWM (comm. temp.)	JC3842	Current Mode PWM (comm. temp.)	SG3842	Direct Replacement
Current Mode PWM (comm. temp.)  Current Mode PWM (comm. temp.)	JC3842A	Current Mode PWM (comm. temp.)	UC3842A	Direct Replacement
Current Mode PWM (comm. temp.)  Current Mode PWM (comm. temp.)	JC3843	Current Mode PWM (comm. temp.)	SG3843	Direct Replacement
Current Mode PWM (comm. temp.)  SG3845  Direct Replacement / Improved Direct	JC3843A	Current Mode PWM (comm. temp.)	UC3843A	Direct Replacement
Current Mode PWM (comm. temp.)  SG3846  Current Mode PWM (comm. temp.)  SG3846  Direct Replacement  Improved  Current Mode PWM (comm. temp.)  SG3846  Direct Replacement  Improved  Current Mode PWM (comm. temp.)  SG3846  Direct Replacement  Improved  Current Mode PWM (comm. temp.)  Current Mode PWM (comm. temp.)  SG3846  Direct Replacement  Improved  Current Mode PWM (comm. temp.)  Current Mode PWM (comm. temp.)  SG3846  Direct Replacement / Improved  Current Mode PWM (comm. temp.)  Current Mode PWM (comm. temp.)  SG3845  Direct Replacement  Improved  Current Mode PWM (comm. temp.)  Current Mode PWM (comm. temp.)  SG3845  Direct Replacement / Improved  Current Mode PWM (comm. temp.)  Current Mode PWM (comm. temp.)  SG3845  Direct Replacement / Improved  Current Mode PWM (comm. temp.)  Current Mode PWM (comm. temp.)  SG3846  Direct Replacement / Improved  Current Mode PWM (comm. temp.)  Current Mode PWM (comm. temp.)  SG3846  Direct Replacement / Improved  Current Mode PWM (comm. temp.)  SG3846  Direct Replacement / Improved  LX5208  Direct Replacement / Improved  LX5207  LX5207  Current Mode PWM (comm. temp.)  SG3846  Direct Replacement / Improved  LX5208  Direct Replacement / Improved  LX5207  Current Mode PWM (comm. temp.)  SG7805  Direct Replacement / Improved  Current Mode PWM (comm. temp.)  SG7805  Direct Replacement / Improved  Current Mode PWM (comm. temp.)  SG7805  Direct Replacement / Improved  Current Mode PWM (comm. temp.)  SG7805  Direct Replacement / Improved  Current Mode PWM (comm. temp.)  SG7805  Direct Replacement / Improved  Current Mode PWM (comm. temp.)  SG846  Direct Replacement / Improved  SG846  Direct Replacement / Improved  Current Mode PWM (comm. temp.)  SG846  Direct Replacement / Improved  SG846  Direc	JC3844	Current Mode PWM (comm. temp.)	SG3844	Direct Replacement
Current Mode PWM (comm. temp.)  SG3846  Direct Replacement  Direct Replacement  Improved  LX5202  Direct Replacement / Improved  LX5203  Direct Replacement / Improved  LX5208  Commanded PWM (comm. temp.)  Current Mode PWM (comm. temp.)  SG3846  Direct Replacement / Improved  LX5203  Direct Replacement / Improved  LX5208  Direct Replacement / Improved  LX5208  Direct Replacement / Improved  LX5207  SG51 Active Terminator, 18-Channel  LX5207  SG51 Active Terminator, 9-Channel  LX5212  SG51 Active Terminator, 9-Channel  LX5213  Direct Replacement / Improved  LX5214  Direct Replacement / Improved  LX5215  Direct Replacement / Improved  LX5216  LX5213  Direct Replacement / Improved  LX5214  Direct Replacement / Improved  LX5215  Direct Replacement / Improved  LX5216  Direct Repl	JC3844A	Current Mode PWM (comm. temp.)	UC3844A	Direct Replacement
Current Mode PWM (comm. temp.)  SG3846  Current Mode PWM (comm. temp.)  SG3846  Direct Replacement  LX5202  Direct Replacement / Improved  LX5203  Direct Replacement / Improved  LX5208  Direct Replacement / Improved  LX5207  SCSI Active Terminator, 18-Channel  LX5207  SCSI Active Terminator, 9-Channel  LX5212  JCC5614  SCSI Active Terminator, 9-Channel  LX5213  Direct Replacement / Improved  LX5214  Direct Replacement / Improved  LX5215  Direct Replacement / Improved  LX5216  LX5216  LX5217  Direct Replacement / Improved  LX5218  Direct Replacement / Improved  LX5218  Direct Replacement / Improved  LX5219  Direct Replacement / Improved  LX5219  Direct Replacement / Improved  LX5219  Direct Replacement / Improved  LX5210  Direct Replacement / Improve	JC3845	Current Mode PWM (comm. temp.)	SG3845	Direct Replacement
SCSI Active Terminator, 18-Channel JC5602 SCSI Active Terminator, 18-Channel JC5603 SCSI Active Terminator, 9-Channel JC5608 SCSI Active Terminator, 18-Channel JC5609 SCSI Active Terminator, 18-Channel JC5609 SCSI Active Terminator, 18-Channel JC5609 SCSI Active Terminator, 18-Channel JC5610 SCSI Active Terminator, 18-Channel JC5612 SCSI Active Terminator, 9-Channel JC5612 JC5614 SCSI Active Terminator, 9-Channel JC7805 Positive Fixed Voltage Regulator, 5V SG7805 JC7812 Positive Fixed Voltage Regulator, 12V SG7812 Positive Fixed Voltage Regulator, 12V SG7812A Direct Replacement JIP Torce	JC3845A	Current Mode PWM (comm. temp.)	UC3845A	Direct Replacement
SCSI Active Terminator, 18-Channel JC5603 SCSI Active Terminator, 9-Channel JC5608 SCSI Active Terminator, 18-Channel JC5609 SCSI Active Terminator, 18-Channel JC5609 SCSI Active Terminator, 18-Channel JC5610 SCSI Active Terminator, 18-Channel JC5612 SCSI Active Terminator, 9-Channel JC5614 SCSI Active Terminator, 9-Channel JC7805 Positive Fixed Voltage Regulator, 5V JC7812 Positive Fixed Voltage Regulator, 12V SG7812 Direct Replacement / Improved JC7812 Direct Replacement / Improved JC7	JC3846	Current Mode PWM (comm. temp.)	SG3846	Direct Replacement
SCSI Active Terminator, 9-Channel UC5608 SCSI Active Terminator, 18-Channel UC5609 SCSI Active Terminator, 18-Channel UC5609 SCSI Active Terminator, 18-Channel UC5610 SCSI Active Terminator, 18-Channel UC5612 SCSI Active Terminator, 9-Channel UC5614 SCSI Active Terminator, 9-Channel UC5615 SCSI Active Terminator, 9-Channel UC5616 SCSI Active Terminator, 9-Channel UC5617 SCSI Active Terminator, 9-Channel UC5618 SCSI Active Terminator, 9-Channel UC5619 SCSI Active Terminator, 9-Channel UC5610 SCSI Active Terminator, 9-Channel UC5611 SCSI Active Terminator, 9-Channel UC5612 SCSI Active Terminator, 9-Channel UC5613 SCSI Active Terminator, 18-Channel UC5614 SCSI Active Terminator, 18-Channel UC5615 SCSI Active Terminator, 18-Channel UC5610 SCSI Active Terminator, 18-Channel UC5611 SCSI Active Terminator, 18-Channel UC5612	JC5601	SCSI Active Terminator, 18-Channel	LX5202	Direct Replacement / Improved ICC
SCSI Active Terminator, 18-Channel SCSI Active Terminator, 9-Channel SCSI Active Terminator, 9-C	JC5602	SCSI Active Terminator, 18-Channel	LX5202	Direct Replacement / Improved ICC
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IC5612 SCSI Active Terminator, 9-Channel LX5212 ICC5614 SCSI Active Terminator, 9-Channel LX5213 Direct Replacement / Improved ICC7805 Positive Fixed Voltage Regulator, 5V SG7805 Direct Replacement Direc	JC5609	SCSI Active Terminator, 18-Channel	LX5208	Direct Replacement / Improved ICC
ICC5614 SCSI Active Terminator, 9-Channel IC7805 Positive Fixed Voltage Regulator, 5V IC7805A Positive Fixed Voltage Regulator, 5V IC7812 Positive Fixed Voltage Regulator, 12V IC7812A SG7812 Positive Fixed Voltage Regulator, 12V SG7812A Direct Replacement / Improved / Im	JC5610	SCSI Active Terminator, 18-Channel	LX5207	JCIRSSA Current Moda PWN (
Positive Fixed Voltage Regulator, 5V SG7805 Direct Replacement  Positive Fixed Voltage Regulator, 5V SG7805A Direct Replacement  Positive Fixed Voltage Regulator, 12V SG7812  Positive Fixed Voltage Regulator, 12V SG7812A Direct Replacement  Positive Fixed Voltage Regulator, 12V SG7812A Direct Replacement	JC5612	SCSI Active Terminator, 9-Channel	LX5212	K1846 Caren Mode PVIA (
Positive Fixed Voltage Regulator, 5V SG7805 Direct Replacement  DICTRODSA Positive Fixed Voltage Regulator, 5V SG7805A Direct Replacement  DICTRODSA Positive Fixed Voltage Regulator, 12V SG7812 Direct Replacement  DICTRODSA Positive Fixed Voltage Regulator, 12V SG7812 Direct Replacement  DICTRODSA Positive Fixed Voltage Regulator, 12V SG7812A Direct Replacement	JCC5614	SCSI Active Terminator, 9-Channel	LX5213	Direct Replacement / Improved ICC
IC7805A Positive Fixed Voltage Regulator, 5V SG7805A Direct Replacement IC7812 Positive Fixed Voltage Regulator, 12V SG7812 Direct Replacement IC7812A Positive Fixed Voltage Regulator, 12V SG7812A Direct Replacement	JC7805	Positive Fixed Voltage Regulator, 5V	SG7805	
JC7812 Positive Fixed Voltage Regulator, 12V SG7812 Direct Replacement JC7812A Positive Fixed Voltage Regulator, 12V SG7812A Direct Replacement	JC7805A	Positive Fixed Voltage Regulator, 5V	SG7805A	THE PARTY OF THE PROPERTY OF THE PARTY OF TH
IC7812A Positive Fixed Voltage Regulator, 12V SG7812A Direct Replacement	JC7812			
	JC7812A			
	JC7812A	Positive Fixed Voltage Regulator, 12V	SG7812A	Direct Replacement
	JC7815			



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~	Part #			escription					rt #	Linfinity Improved Alte	
UC UC UC	itrode (continue 7905 7905A 7905A 7912 7912A 7915	Negative Fi Negative Fi Negative Fi Negative Fi Negative Fi	Negative Fixed Voltage Negative Fixed Voltage Negative Fixed Voltage Negative Fixed Voltage Negative Fixed Voltage Negative Fixed Voltage		e Regulator, 5V e Regulator, 12V e Regulator, 12V e Regulator, 15V			SG7905 SG7905A SG7912 SG7912A SG7915 SG7915A		Direct Replacement	
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# **Package Cross-Reference**

### THRU-HOLE PACKAGES

Thru-Hole P		LINFINITY	Cherry	Linear Tech	Motorola	NSC	Signetics	Sprague	Texas Instruments	Unitrod
STANDARD PL	ASTIC									
	DIP 8 - Pin	М	N	N8	P1	N, N8	N	М	Р	N
THY WY	DIP 14, 16, 18, 20, & 24 - Pin	N	N	N	P2	N, N14	N	A	N,NE,NG	N
MANAM	DIP 16 - Pin (Batwing)	W	Mag.	-	Ver a	(Segge)	nesila/bja	В	_ Aaye	104
	TO-92 3 - Pin	LP		Z	Р	Z	-		LP	
POWER PLAST	IC					18 B B B				
	TO-220 3 & 5 - Pin	Р		Т	Т	Т	U	Z	КС	Т
	TO-247 3 - Pin	٧	-	Р		-	-	-	-	
CERAMIC	DIP 8 - Pin	у	J	J8	U	J, J8	FE	-	JG	J
	DIP 14, 16 (TO-116), & 18 - Pin	J	J	J	L	J, J14	F	R	J	J
	Hermetic TO-257 3 - Pin	IG		-	-	-	-	-	-	IG
METAL CAN										
	2 (TO-46), 3 (TO-52) - Pin	z	-	Н		Н	-	-	-	
	3 (TO-39), 8 (TO-99), 10 (TO-96, TO-100), & 12 (TO-101) - Pin	т		Н	G, H	Н	Н	-	-	н
	TO-3 3 - Pin	К		К	К	К	-	٧	-	К
	TO-66 3, 5, & 9 - Pin	R	-	-	R	-	-		-	-



# Package Cross-Reference

### SURFACE-MOUNT PACKAGES

Surface Moun	t Packages	LINFINITY	Cherry	Linear Tech	Motorola	NSC	Signetics	Sprague	Texas Instruments	Unitrode
STANDARD PLAS	STIC				A PROPERTY.					E PER CONTRACTOR
Carl.	SOIC W 8 - Pin	DM	a -	\$8	D	М	D	ack J 14, 16, 20	D Flate	
addiddd	SOIC 14 & 16 - Pin	D		S	D	М	D	L	221 D	D
added de de	SOWB 16, 18, & 20 - Pin	DW		S	D	М	DW	LW	DW	D
THE THE	PLCC 20 & 28 - Pin	Q	FN	-	FN	٧	-	EP	FN	Q
Source Continue	TQFP 32 & 48 - Pin	TF	_	-	-		-	-	· -	
de d	TSSOP 20 - Pin	PW	-	F	-	-	-	-	PW	-
Tetricite de la	SSOP 20, 24, 28, 36 - Pin	DB		G	-	-	-	-	DB	-
	SOT-89 3 - Pin	PK	-	-	-	-	-	-	PK	
POWER PLASTIC		A PARTIES		THE PARTY		9.883				
and the state of	SOIC Power 16 - Pin	DP	-	-	-		-	-	-	DP
and the little of the little o	SOWB Power 20 & 28 - Pin	DWP	-	-	-			-	-	DWP
in the desired the least of the	TSSOP Power 24 - Pin	PWP	-	-			-	-	-	PWP
	TO-263AA 3 & 5 - Pin	DD	-	М			-	3 ·	-	-
	TO-223 3 - Pin	ST	-	ST		-	-	-	-	-



# **Package Cross-Reference**

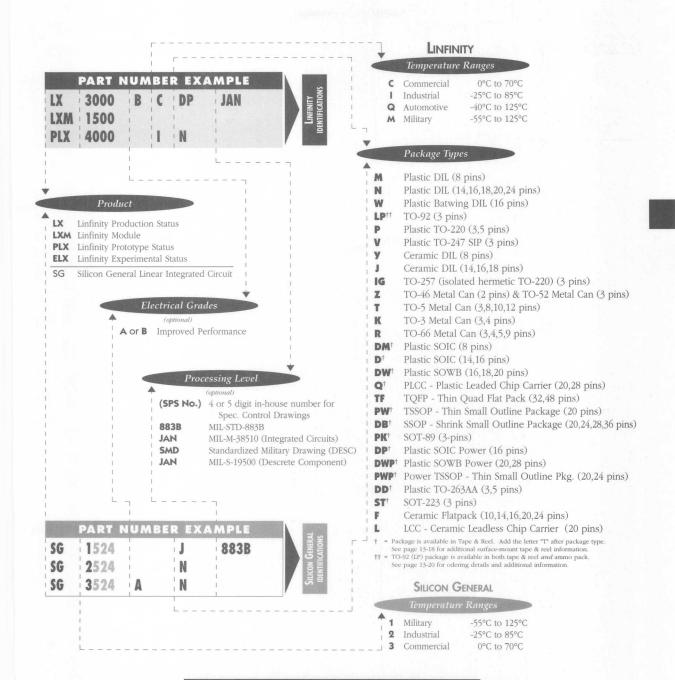
### SURFACE MOUNT PACKAGES

Surface Mount Packages		LINFINITY	Cherry	Linear Tech	Motorola	NSC	Signetics	Sprague	Texas Instrument	Unitrode	
CERAMIC		oack 14, 16, 20 1 - Pin	F	M	w	82 F	F	1643		9 - 8 W	9
	LCC 20 - 1	Pin	L	M	G L	FN	E	G	EK	FN	ľ
. 0	WG	MI	Wa II.	M	SI.				61. 8 20 - 210	1 /61	



### **Product Identification**

#### PART NUMBER CODING



### Notes

#### ymuraud

## Plastic Offic (6 princ)
## Plastic Offic (6 princ)
## Plastic Barwing Offic (16 princ)
## TO-92 (3 princ)
## Plastic TO-270 (3.5 princ)
## Plastic TO-270 (3.5 princ)
## Certainle Offic (8 princ)
## Certainle Offic (8 princ)
## TO-35 Vetail Care (2 princ) (3.70-35 Vetail Care (3.8, 10.12 princ)
## TO-35 Vetail Care (3.8, 10.12 princ)
## TO-35 Wetail Care (3.8, 10.12 princ)

TO-5 Metal Can (3.8.10.12 pins) TO-5 Metal Can (3.4 pins) TO-66 Metal Can (3.4.5.9 pins) Plastic SCIC (8 pins)

Plastic SORC (14,16 pins)
W Plastic SOWB (16,16,20 pins)

TOPP - Thin Quick Place (32, 48 pins)
WE TASOF - Thin Small Outline Package (20 pins)
WE SOOK - Shried small Outline Package (20 pins)

ROT-89 (2-pins) Plastic SOSC Power (16 pins)

Will Physic TO-264AA (3.5 pins)

(P) SUP-225 (5 pms) Geramic Platpack (10.44.16.20,24 pins)

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#### SHICON GENERAL

1 Millians -55°C to 125°C 2 Industrial - 55°C to 85°C





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Obta low Sarety Curent, Carrent Mode Pivol. Second-Generalist Power Factor Controller	
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Signal Conditioning Circuits	S SESSAN
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Other Linear Circuits	7: 68X7; 0868XT 72859, 058XY;
Military Products	**************************************
Discontinued Products	SGREEN SGL20-xx SGL121 :37/337, SGL37A/237A/337A SGL40-xx140A-xx
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SG140-x.x/140A-x.x	Positive Fixed Voltage Regulator	
SG1532/2532/3532	Precision Positive Adjustable Voltage Regulator	
SG723	Precision Positive Adjustable Voltage Regulator	
SG7800/7800A Series	Positive Fixed Voltage Regulators - 5V, 6V, 8V, 12V, 15V, 18V, 20V, 24V	
SG7900/7900A Series	Negative Fixed Voltage Regulators - 5V, 5.2V, 8V, 12V, 15V, 18V, 20V, 24V	

**Bold =** New Product, \*Bold Italic = Preliminary



# **Section Index**

### POWER SUPPLY CIRCUITS

	Standard Linear Voltage Re	gulators (cont'd.)	
	SG29055/29055A SG29085/29085A SG29125/29125A	Low Dropout Dual Regulator — 5V, 5V Low Dropout Dual Regulator — 8.2V, 5V Low Dropout Dual Regulator — 12V, 5V	6-305
	Supervisors	1. A 2. STATE OF THE PROPERTY OF THE PARTY	S IN SECTION
	LX7001 *LX7705 MC33064/34064 MC33164-3/34164-3 SG1543/2543/3543 SG1544/2544/3544 SG1548/2548/3548 SG3546 SG33164/34164	Transient Immune Voltage Supervisor  5V Supply Voltage Supervisor w/ Reference Undervoltage Sensing Circuit  3V Undervoltage Sensing Circuit Power Supply Output Supervisory Circuit Low Voltage Supervisory Circuit Quad Power Fault Monitor  3.3V Undervoltage Sensing Circuit Micropower Sensing Circuit	
)	MOSFET Drivers		
	SG1626/2626/3626 SG1644/2644/3644	Dual High-Speed MOSFET Driver Dual High-Speed MOSFET Driver	
•	Support Functions		EN RUSSIES SER
	SG1540/2540/3540 SG1549/2549/3549	Off-Line Start-Up Controller	
)	Switching Regulator Output	Stages	THE RESIDENCE OF THE PARTY.
	SM600/601/602/610/611/612 SM625/626/627 SM645/646/647	Switching Regulator Power Output Stages Switching Regulator Power Output Stages Switching Regulator Power Output Stages	6-353
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Bold = New Product, \*Bold Italic = Preliminary





### POWER SUPPLY CIRCUITS

### PWM IC Controllers

					1		1000	PE	RFORMA	ANC	E C	HAI	RACT	FERI	STI	CS	
Device Type			P. P	200	In lotes	A STATE OF THE STA	100 Se LOCK	PE CHIMITIAN ON THE PROPERTY OF THE PROPERTY O	Mountain Control of the Control of t	Weng Scilloro	min	To the control of the	Separation of the separation o	Pensiller	10, lau 10t	Mak Supe Supe Supe Supe	Packages
Voltage Mode PWM's	PAGE #	10	30	S Ma	1/3	Se Se	2 /2	TO ORDE	Man fre	15	ON N	200	200	A ALL	100	No No No	PACKAGES
SG1524/2524/3524	6-239	±4					1	40V 100mA	300KHz	1	2		1			<50%	J, N, D, L
SG1524B/2524B/3524B	6-241	±1		1	1	1	1	60V 200mA	500KHz	1	2		1		1	<50%	J, N, DW, I
SG1525A/2525A/3525A	6-243	±1	1	1	1		1	35V 0.4A	500KHz		2	1	1	1		<50%	J, N, DW, I
SG1526/2526/3526	6-245	±1	1	1	1	1	1	35V 0.4A	400KHz		2	1	1	1	1	<50%	J, N, DW, I
SG1526B/2526B/3526B	6-247	±1	1	1	1	1	1	35V 0.4A	500KHz		2	1	1	1	1	<50%	J, N, DW, I
SG1527A/2527A/3527A	6-243	±1	1	1	1		1	35V 0.4A	500KHz		2	1	1	1		<50%	J, N, DW,
SG1529/2529/3529	6-249	±1		1	1	1	1	60V 200mA	500KHz	1	2		1		1	<50%	J, N, DW
021.A					-	55E				Z	3,93	_	3.6		3.1	MARIA	OF THE 1
LX1562/1563	DESCRIPTION		C		R FACROL			EY FEATUR	Internal st Internal cu Improved Clamped I Multiplier Internal ov PWM outp	micro E.A. o clamp	sens opow outpul o limi	e blan er star for lo ts man	rt-up cu ower tu ximum tion rep	irn-on input blaces	over curr built	rshoot. ent. in C.S. off	V DN
LX1570/1571	Description		SID	ONO	DDUL US SI NTRO	ECON	DAR	A. FEATUR 3.	Replaces on-resistar Look-Ahe before the Lower ove Lower pea	nce Mead Sve AC i erall seral seral	osfi witch nput, ysten rent	ing <sup>TM</sup> to acl cost. stress	ensure hieve 1	es swi	tch tu energ	gy transfer	PACKAGES
-					•							-					-
SG3561A	DESCRIPTION	Г	C		R FA			FEATUR 2:	Optimized Micro-pow Low opera Internal 50 Totem pol Automatic	ver sta ating % refe le out	art-up curre erence put s	modent con e. tage.	e. isumpt	ion.			ACKAGES NO



### POWER SUPPLY CIRCUITS

#### PWM IC Controllers and well

							*	Perf	ORMANC	EC	СНА	RAG	CTER	ISTICS	
		W. W		/	The state of the s	/	/	30V	>//	/	/		To de Original de la composição de la co	///	
			/	Chia	/	15	1/5	N. Continue	Morning Control of Con	10		lin's	2/2/	2/3	PACKAGES
		/	SAL S	/	Sea. Mare	35	Shir brown	Salar Salar	Noviment of the Control of the Contr	The Sollie	1	0 0	Supplied Sup	West Of the Party	100
DEVICE TYPE  Current Mode PWM's	PAGE #	2000	/8	23/1	0 3	38/3	The Se	Son State	No Marino	2/2	05/3	000	de de	To Take	Pressure
LX1552	6-15	250		6	16	1		30V 1A	500KHz		1	1		<100%	PACKAGES M, DM, D Y, PW
LX1553 ·	6-15	250		1	9	1		30V 1A	500KHz		1	1		<100%	M, DM, D Y, PW
LX1554	6-15	250		6	16	1		30V 1A	500KHz		1	1		<50%	M, DM, D Y, PW
LX1555	6-15	250		1	9	1		30V 1A	500KHz		1	1		<50%	M, DM, D Y, PW
UC1842A/2842A/3842A	6-357	500		6	16	1		30V 1A	500KHz		1	1		<100%	M, DM D, Y
UC1843A/2843A/3843A	6-357	500		1	9	1		30V 1A	500KHz		1	1		<100%	M, DM D, Y
UC1844A/2844A/3844A	6-357	500		6	16	1		30V 1A	500KHz		1	1		<100%	M, DM D, Y
UC1845A/2845A/3845A	6-357	500		1	9	1		30V 1A	500KHz		1	1		<100%	M, DM D, Y
SG1842/2842/3842	6-275	1000		6	16	1		30V 1A	500KHz	1	1	1		<100%	J, N, Y, M D, DM, F, L
SG1843/2843/3843	6-275	1000		1	9	1		35V 1A	500KHz	1	1	1		<100%	J, N, Y, M D, DM, F, L
SG1844/2844/3844	6-289	1000		6	16	1		35V 1A	500KHz	1	1	1		<50%	J, N, Y, M D, DM, F, L
SG1845/2845/3845	6-289	1000		1	9	1		35V 1A	500KHz	1	1	1		<50%	J, N, Y, M D, DM, F, L
LX1823	6-71	1000	1	1	9	1	1	30V 1.5A	1.5MHz	1	1	1	1	<100%	J, N, DW Q, L
SG1825C/2825C/3825C	6-267	1000	1	1	9	1	1	30V 1.5A	2MHz	1	2	1	1	<50%	J, N, DW Q, L
SG1846/2846/3846	6-301	n/a	1	0.4	8	1	1	40V 500mA	500KHz	1	2	1	1	<50%	J, N, DW F, L



#### POWER SUPPLY CIRCUITS

# Low Dropout Positive Voltage Regulators ADJUSTABLE

Device Type		Output Current	Maximum	CHARACTERIST  Maximum  Input Voltage (V)	Output Voltage Range (V)		
7 30 7 61 5	PAGE #		Drop Out (V)	Notable		Packages	
LX8582A	6-137	8.5A	1.3	10	1.25 to 8	P, V	
LX8383A			1.3	10	1.25 to 8	sta Transmit	
LX8383	6-103	7.5A	1.5	10 20	1.25 to 8	P, V	
LX8584A	6-139	7A	1.2	10	1.25 to 8	P, V	
LX8584/8584B	0-139	/A	1.4	10	1.25 to 8		
LX8586A	(1/1)		1.1	10	1.25 to 8	P, V	
LX8586	6-143	6A	1.3	10	1.25 to 8	1, 1	
LX8554	6-135		1.0	10	1.25 to 8	P, DD	
LX8384A		5A	1.3	10	1.25 to 8	P, DD, V	
LX8384	6-111		1.5	10	1.25 to 8		
LX8585A	6-141	4.6A	1.2	10	1.25 to 8	P, DD	
LX8585	0-141	4.0A	1.4	10	1.25 to 8		
LX8587A	6-145		1.2	10	1.25 to 8	P, DD	
LX8587	0-145	3A	1.3	10	1.25 to 8		
LX8385	6-119		1.5	20	1.25 to 18	P, DD	
LX8386	6-127	1.5A	1.5	20	1.25 to 18	P, DD	
LX8941	6-155	1A	0.8	26	1.25 to 25	P, DD	
LX8020/8020A	6-99	200mA	0.2 Typ.	10	1.25 to 8	LP, DM	



### POWER SUPPLY CIRCUITS

# Low Dropout Positive Voltage Regulators FIXED

Device Type	PAGE #	Output Current	Maximum Drop Out (V)	E CHARACTERISTI  Maximum  Input Voltage (V)	Output Voltage (V)	PACKAGES
LX8940	6-151	1A	0.8	24	5	ST
SG29055/55A	6-303		0.6	26	5/5	
SG29085/85A	6-305	0.5A	0.6	26	8/5	P
SG29125/125A	6-307		0.6	26	12/5	
LX5285	6-81	800mA	1.1		2.85	Р
LX8020-28/A-28	6-99		0.2 Typ.	10	2.85	
LX8020-30/A-30	6-99		0.2 Typ.	10	3.0	
LX8020-33/A-33	6-99	200mA	0.2 Typ.	10	3.3	LP, DM
LX8020-48/A-48	6-99		0.2 Тур.	10	4.8	
LX8020-50/A-50	6-99		0.2 Тур.	10	5.0	
, ve	N.	2	370		ssa (B)	



### POWER SUPPLY CIRCUITS

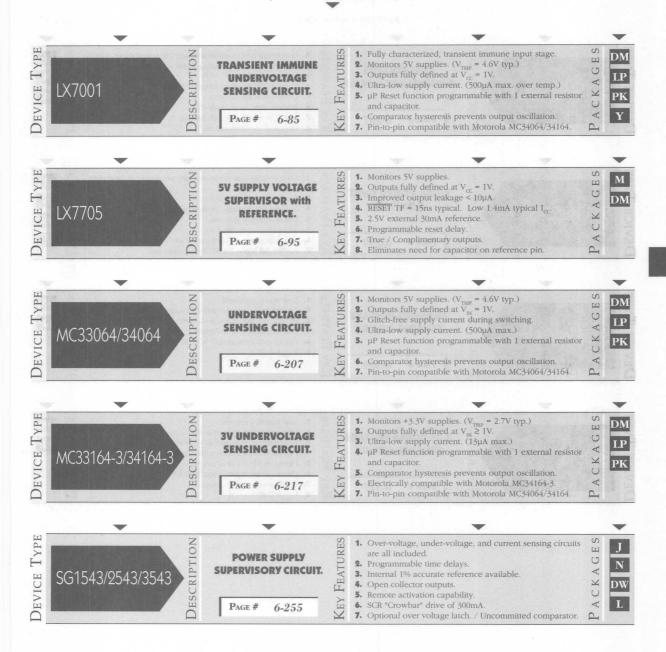
### Standard Linear Voltage Regulators

		1	PERF	ORMANC	E CHAR	ACTERISTI		
DEVICE TYPE	PAGE #	Output Current	Polarity	Fixed	Adjust.	Max. Input Voltage	Output Voltage (V)	PACKAGES
SG117/117A	6-229		Positive		1	35V	1.2V to 37V	K
SG140/140A	6-237		Positive			35V	5, 6, 8, 12, 15 18, 20, 24V	K R IG* L
SG7800/7800A SG109	6-347	1.5A°	Positive	1		35V	5V	K
SGR117A	6-231	1.34	Positive		1	35V	-1.2V to -37V	R IG
SG137/137A	6-235		Negative		1	35V	-1.2V to -37V	K
SG120 SG7900/7900A	6-233		Negative	1		35V	-5, -5.2, -8, -12, 15, -18, -20V	R IG L
SGR117A	6-231		Positive		1	35V	1.2V to 37V	Т
SG7800/7800A	6-347		Positive	1		35V	5, 6, 8, 12, 15, 18, 20, 24	
SG109	6-227	0.5A	Positive	1		35V	5V	
SG137/137A	6-235		Negative		1	35V	-1.2 to -37V	
SG120 SG7900/7900A	6-233 6-349		Negative	1		35V	-5, -5.2, -8, -12, -15, -18, -20V	
SG1532	6-251	0.14	Positive		1	50V	2V to 38V	K, R, IG
SG723	6-345	0.1A	Positive		1	50V	2V to 38V	J, T, F, L



#### POWER SUPPLY CIRCUITS

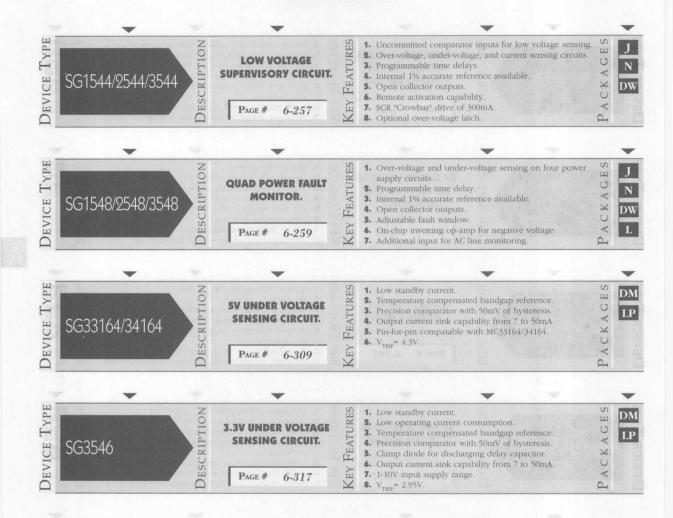
#### Supervisory Circuits





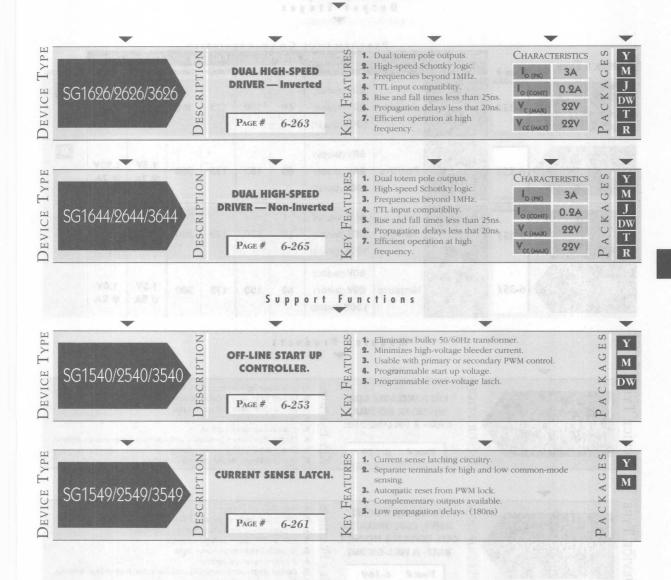
#### POWER SUPPLY CIRCUITS

Supervisory Circuits



#### POWER SUPPLY CIRCUITS

MOSFET Drivers

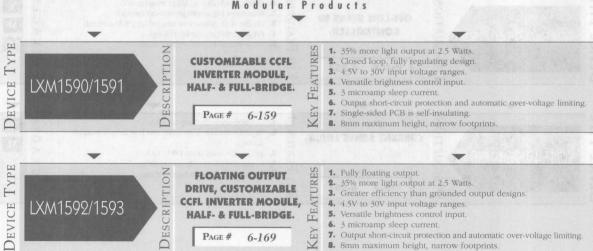


### POWER SUPPLY CIRCUITS

Switching Regulator Output Stages

Driver Tier	Peak Output		Input/Output	Rise Ti	me (ns)	Fall Ti	me (ns)	On-State	: Voltage	CORRES
DEVICE TYPE PAG	E# Current	Polarity	Voltage	Voltage	Current	Voltage	Current	Transistor	Diode	PACKAGES
SM645/646/647 6-3	55 20A	Positive	60V (SM645) 80V (SM646) 100V (SM647)	60	150	175	300	1.5V @ 7A	1.25V @ 7A	K
SM625/626/627 6-3	53 15A	Positive	60V (SM625) 80V (SM626) 100V (SM627)	60	150	175	300	1.5V @ 7A	1.25V @ 7A	R
SM600/601/602 6-3		Positive	60V (SM600) 80V (SM601) 100V (SM602)	60	150	175	300	1.5V @ 2A	1.0V @ 2A	
SM610/611/612 6-3	5A 51	Negative	60V (SM600) 80V (SM601) 100V (SM602)	60	150	175	300	1.5V @ 2A	1.0V @ 2A	

#### Modular Products



8. 8mm maximum height, narrow footprints.

#### POWER SUPPLY CIRCUITS

Modular Products

DEVICE TYPE
TWE
TYPE
TO-9651WY
DESCRIPTION

WIDE INPUT CCFL INVERTER MODULE, HALF- & FULL-BRIDGE.

Page # 6-185

1. 15 to 30% more light output.

2. Closed loop, fully regulating design.

7V to 30V input voltage range.
 Versatile brightness control input.

5. 3 microamp sleep current.

6. Output short-circuit protection and automatic over-voltage limiting.

7. Single-sided PCB is self-insulating.

8. 8mm maximum height, narrow footprints.

DEVICE TYPE
TO-L651WX
Description

5V CCFL
INVERTER MODULE,
HALF- & FULL-BRIDGE.

PAGE # 6-191

1. 15 to 30% more light output.

2. Closed loop, fully regulating design.

3. 4.5V to 7V input voltage range.

4. Versatile brightness control input.

5. 3 microamp sleep current.

6. Output short-circuit protection and automatic over-voltage limiting.

7. Single-sided PCB is self-insulating.

8. 8mm maximum height, narrow footprints.

DEVICE TYPE
10-8651WX
DESCRIPTION

12V CCFL INVERTER MODULE, HALF- & FULL-BRIDGE.

PAGE # 6-197

1. 15 to 30% more light output.

2. Closed loop, fully regulating design.

3. 10V to 14V input voltage ranges.4. Versatile brightness control input.

5. 3 microamp sleep current.

6. Output short-circuit protection and automatic over-voltage limiting.

7. Single-sided PCB is self-insulating.

8. 8mm maximum height, narrow footprints.

LXM1600-05/-12 LXM1600A-05/-12

5V/12V PENTIUM® PRO (VRM) VOLTAGE REGULATOR MODULE.

PAGE # 6-203

DESCRIPTION

1. Maximum output current 12A (typ.).

2. Total output tolerance of less than ±5%.

3. Adjustable output voltage using a four bit word.

Adjustable output voltage using a four of word.
 Over-voltage detection crowbars the output voltage in the event of pass transistor failure - 100% processor protetion.

5. High efficiency — 85% (typ.).

6. Power Good signal indicates low output voltage.

7. Short-circuit protection. 8. Output Enable/Shutdown.



### Notes







### LX1552/3/4/5

ULTRA-LOW START-UP CURRENT, CURRENT-MODE PWM

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

The LX155X family of ultra-low start-up current (250µA max.), current mode control IC's offer new levels of energy efficiency for offline converter applications. They are ideally optimized for personal computer and CRT power supplies although they can be used in any number of off-line applications where energy efficiency is critical. Coupled with the fact that the LX155X series requires a minimal set of external components, the series offers an excellent value for cost conscious consumer applications.

Optimizing energy efficiency, the LX155X series demonstrates a significant power reduction as compared with other similar off-line controllers. Table 1 compares the SG384X, UC384XA and the LX155X start-up resistor power dissipation. The LX155X offers an overall 4X reduction in power dissipa-

tion. Additionally, the precise oscillator discharge current gives the power supply designer considerable flexibility in optimizing system duty cycle consistency.

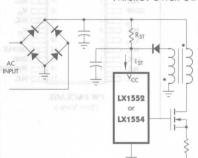
The current mode architecture demonstrates improved load regulation, pulse by pulse current limiting and inherent protection of the power supply output switch. The LX155X includes a bandgap reference trimmed to 1%, an error amplifier, a current sense comparator internally clamped to 1V, a high current totem pole output stage for fast switching of power mosfet's, and an externally programmable oscillator to set operating frequency and maximum duty cycle. The undervoltage lock-out circuitry is designed to operate with as little as 250µA of supply current permitting very efficient bootstrap designs.

#### KEY FEATURES

- ULTRA-LOW START-UP CURRENT (150µA typ.)
- TRIMMED OSCILLATOR DISCHARGE CURRENT (±2% typ.)
- INITIAL OSCILLATOR FREQUENCY BETTER THAN ±4%
- OUTPUT PULLDOWN DURING UYLO
- PRECISION 2.5V REFERENCE (±2% max.)
- ☐ CURRENT SENSE DELAY TO OUTPUT (150ns typ.)
- AUTOMATIC FEED FORWARD COMPENSATION
- PULSE-BY-PULSE CURRENT LIMITING
- ENHANCED LOAD RESPONSE CHARACTERISTICS
- UNDER-VOLTAGE LOCKOUT WITH HYSTERESIS
- □ DOUBLE PULSE SUPPRESSION
- ☐ HIGH CURRENT TOTEM POLE OUTPUT (±1Amp peak)
- 500kHz OPERATION

#### PRODUCT HIGHLIGHT

Typical Application of LX155X Using Its MicroPower Start-Up Feature



L	ABLE I		
Design Using	SG384x	UC384xA	LX155x
Max. Start-up Current Specification (I <sub>ST</sub> )	1000µA	500μΑ	250μΑ
Typical Start-Up Resistor Value (R <sub>ST</sub> )	62ΚΩ	124ΚΩ	248ΚΩ
Max. Start-Up Resistor	2.26W	1.13W	0.56W

Note: Calculation is done for universal AC input specification of  $V_{AGMN}=90V_{BMS}$  to  $V_{AGMN}=265V_{BMS}$  using the following equation: (Resistor current is selected to be  $2*I_{sT}$  at  $V_{AGMN}$ )

$$R_{ST} = \frac{V_{ACMIN}}{\sqrt{2} * I_{ST}} , P_{R} = \frac{2V_{ACMAX}^{2}}{R_{ST}}$$

#### APPLICATIONS

- ECONOMY OFF-LINE FLYBACK OR
- FORWARD CONVERTERS

  DC-DC BUCK OR BOOST CONVERTERS
- LOW COST DC MOTOR CONTROL

AVAILAE	BLE OPTI	ONS PER	PART #
Part #	Start-Up Voltage	Hysteresis	Max. Duty Cycle
LX1552	16V	6V	<100%
LX1553	8.4V	0.8V	<100%
LX1554	16V	6V	<50%
IV1555	0 41/	0.87	-50%

THE REAL PROPERTY.		PACKAGE OF	RDER INFORMA	TION	
T <sub>A</sub> (°C)	M Plastic DIP 8-pin	DM Plastic SOIC 8-pin	D Plastic SOIC 14-pin	Y Ceramic DIP 8-pin	PW TSSOP 20-pin
0 to 70	LX155xCM	LX155xCDM	LX155xCD	_	LX155xCPW
-40 to 85	LX155xIM	LX155xIDM	LX155xID	_	_
-55 to 125	_	_	_	LX155xMY	:

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX1552CDMT)

#### ABSOLUTE MAXIMUM RATINGS (Note 1)

	2011
Supply Voltage (Low Impedance Source)	
Supply Voltage (I <sub>cc</sub> < 30mA)	f Limiting
Output Current	±1A
Output Energy (Capacitive Load)	5µJ
Analog Inputs (Pins 2, 3)0.3V	to +6.3V
Error Amp Output Sink Current	10mA
Power Dissipation at T <sub>A</sub> = 25°C (DIL-8)	1W
Operating Junction Temperature	
Ceramic (Y Package)	150°C
Plastic (M, DM, D, PW Packages)	150°C
Storage Temperature Range65°C t	o +150°C
Lead Temperature (Soldering, 10 Seconds)	300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal. Pin numbers refer to DIL packages only.

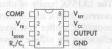
#### THERMAL DATA

#### M PACKAGE:

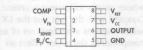
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{J_A}}$	95°C/W
DM PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	165°C/W
D PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	120°C/W
y PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	130°C/W
PW PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{J_A}}$	144°C/W

Junction Temperature Calculation:  $T_j = T_A + (P_D \times \theta_{JA})$ . The  $\theta_{JA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow

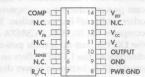
#### PACKAGE PIN OUTS



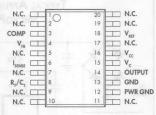
M & Y PACKAGE
(Top View)



DM PACKAGE (Top View)



D PACKAGE (Top View)



PW PACKAGE (Top View)



# **ULTRA-LOW START-UP CURRENT, CURRENT-MODE PWM**

## PRODUCTION DATA SHEET

## ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for LX155xC with  $0^{\circ}$ C  $\leq$   $T_{A} \leq$   $70^{\circ}$ C, LX155xI with  $-40^{\circ}$ C  $\leq$   $T_{A} \leq$   $85^{\circ}$ C, LX155xM with  $-55^{\circ}$ C  $\leq$   $T_{A} \leq$   $125^{\circ}$ C;  $V_{CC}$ =15V (Note 5);  $R_{r}$ =10K;  $C_{r}$ =3.3nF. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.

Parameter	Symbol	Test Conditions		55xI/1!			X155x		Unit
raidiletei	3,111001	rest conditions	Min.	Тур.	Max.	Min.	Тур.	Max.	0
Reference Section				нОне	ULT 1807	A SPE	loV.no	751900	S. cust
Output Voltage	V <sub>REF</sub>	$T_A = 25$ °C, $I_L = 1$ mA	4.95	5.00	5.05	4.95	5.00	5.05	٧
Line Regulation `		$12 \le V_{ N} \le 25V$	7.5	6	20		6	20	m\
Load Regulation	edx T	$1 \le I_0 \le 20 \text{mA}$		6	25		6	25	m\
Temperature Stability (Note 2 & 7)	-	2400 - 0.0002 - 0.0024000		0.2	0.4		0.2	0.4	mV/°
Total Output Variation	1.5	Over Line, Load, and Temperature	4.9		5.1	4.9		5.1	٧
Output Noise Voltage (Note 2)	VN	$10Hz \le f \le 10kHz, T_A = 25^{\circ}C$		50			50		μV
Long Term Stability (Note 2)		T <sub>A</sub> = 125°C, t = 1000hrs		5	25		5	25	m\
Output Short Circuit	I <sub>sc</sub>		-30	-100	-180	-30	-100	-180	m/
Oscillator Section							2003	nov qu	P-3 180 G
Initial Accuracy (Note 6)	G F	T <sub>A</sub> = 25°C	48.5	50.5	52.5	48.5	50.5	52.5	kH:
	VI	$T_A = 25$ °C, $R_T = 698\Omega$ , $C_T = 22$ nF, LX1552/3 only	56	58	60	56	58	60	kH
Voltage Stability	Asserting	12 ≤ V <sub>cc</sub> ≤ 25V	11 14 14	0.2	1	CALCULA.	0.2	1	%
Temperature Stability (Note 2)	1	$T_{MIN} \le T_A \le T_{MAX}$		5			5	200	%
Amplitude (Note 2)	v villed	V <sub>PINA</sub> peak to peak		1.7			1.7		٧
Discharge Current	I <sub>D</sub>	T <sub>A</sub> = 25°C, V <sub>PIN 4</sub> = 2V	8.0	8.3	8.6	8.0	8.3	8.6	m/
age the maximum & meanum selection	Lolini	$V_{\text{PIN 4}} = 2V, T_{\text{MIN}} \le T_{\text{A}} \le T_{\text{MAX}}$	7.6	out in	8.8	7.8	DV is	8.8	m/
Error Amp Section	Effective	FIN 9 / MIN A MOX	audi nous	Boson	nupe	DODUU	933 July	SUO 8	
Input Voltage		$V_{PIN,1} = 2.5V$	2.45	2.50	2.55	2.45	2.50	2.55	V
Input Bias Current	I <sub>B</sub>	PIN	20	-0.1	-1	2110	-0.1	-0.5	U/A
Open Loop Gain	A <sub>VOI</sub>	$2 \le V_0 \le 4V$	65	90	pro-rocal	65	90	0.0	dB
Unity Gain Bandwidth (Note 2)	UGBW	T <sub>A</sub> = 25°C	1137	0.6	Taylor V	COTT W	0.6	V. Lines	МН
Power Supply Rejection Ratio (Note 3)	PSRR	$12 \le V_{cc} \le 25V$	60	70		60	70		dE
Output Sink Current	I <sub>OL</sub>	$V_{PIN \Omega} = 2.7V, V_{PIN \Omega} = 1.1V$	2	4	2	2	4	30 T	m/
Output Source Current	IOH	$V_{\text{PIN } 9} = 2.3 \text{V}, V_{\text{PIN } 1} = 5 \text{V}$	-0.5	-0.8	94	-0.5	-0.8		m/
Output Voltage High Level	V <sub>OH</sub>	$V_{PIN.9} = 2.3V$ , $R_L = 15K$ to ground	5	6.5		5	6.5		V
Output Voltage Low Level	V <sub>OI</sub>	$V_{\text{PIN }\circ} = 2.7V, R_{\text{I}} = 15K \text{ to } V_{\text{psf}}$	10	0.7	1.1		0.7	1.1	V
Current Sense Section	OL	PN 2	()	\$24155	EV (3.5	17.27			
Gain (Note 3 & 4)	A <sub>VOL</sub>	- IOCCI VALCETI VIAS	2.85	3	3.15	2.85	3	3.15	VA
Maximum Input Signal (Note 3)	YVOL	V <sub>PIN 1</sub> = 5V	0.9	1	1.1	0.9	1	1.1	V
Power Supply Rejection Ratio (Note 3)	PSRR	$12 \le V_{cc} \le 25V$	0.7	70	1.1	0.7	70	1.1	dB
Input Bias Current	I <sub>R</sub>	12 = 1 <sub>CC</sub> = 231	1	-2	-10		-2	-5	μА
Delay to Output (Note 2)	T <sub>PD</sub>	V <sub>PIN 3</sub> = 0 to 2V	+	150	300		150	300	ns
Output Section	*PD	1 PIN 3 - 0 CO 21	1	100	000		150	500	113
Output Voltage Low Level	V	I - 00m A	1	0.1	0.4		0.4	0.4	1/
Output voltage Low Level	V <sub>OL</sub>	$I_{SINK} = 20$ mA		0.1	0.4		0.1	0.4	V V
Output Voltage High Level	V	$I_{SINK} = 200\text{mA}$	42	1.5	2.2	42	1.5	2.2	
Output Voltage High Level	V <sub>OH</sub>	I <sub>SOURCE</sub> = 20mA	13	13.5	12/1	13	13.5		٧
Dies Time (Mete O)	-	I <sub>SOURCE</sub> = 200mA	12	13.5	100	12	13.5	100	٧
Rise Time (Note 2)	T <sub>R</sub>	$T_A = 25^{\circ}C, C_L = 1 \text{nF}$	1.76	50	100		50	100	ns
Fall Time (Note 2)	T <sub>F</sub>	$T_A = 25^{\circ}C, C_L = 1nF$	-	50	100		50	100	ns
UVLO Saturation	V <sub>SAT</sub>	$V_{cc} = 5V$ , $I_{SINK} = 10mA$		0.7	1.2		0.7	1.2	٧

(Electrical Characteristics continue next page.)



# ULTRA-LOW START-UP CURRENT, CURRENT-MODE PWM

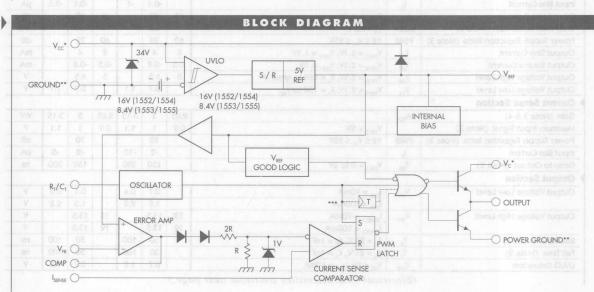
## PRODUCTION DATA SHEET

			NI VAL	THIVET		-	VZ I-I-R		COLUMN TO A STREET
Parameter	Symbol	Test Conditions	NAME OF TAXABLE PARTY.	55xl/15 Typ.	AND DESCRIPTION OF THE PARTY OF	Min.	X155x Typ.	The Real Property lies	Units
Under-Voltage Lockout Section		character form and appropriate and the control of the second seco	arrance in the		1000 000	esia estrua			
Start Threshold	V <sub>ST</sub>	1552/1554	15	16	17	15	16	17	٧
		1553/1555	7.8	8.4	9.0	7.8	8.4	9.0	٧
Min. Operation Voltage After Turn-On		1552/1554	9	10	11	9	10	11	٧
	367	1553/1555	7.0	7.6	8.2	7.0	7.6	8.2	٧
PWM Section		A535 A5 81					96	nejuga	Nanu.
Maximum Duty Cycle		1552/1553	94	96		94	96	d FS-M	%
Wm 4.0 9.0 6.0 9.0		$1552/1553$ , $R_T = 698\Omega$ , $C_T = 22nF$		50	0 = 270	93) 61	50	11/13/8/10	%
	100	1554/1555	47	48		47	48	nepud	%
Minimum Duty Cycle		12 00 = 1 2 min 21 2 min 1	- 10		0	MIT SHE	mer a	0	%
Power Consumption Section	20	81(630) = 1,2 (81 = 1			18	90(0)()	Annicas:	C Hittory	Sucra
Start-Up Current	I <sub>ST</sub>		7	150	250		150	250	μА
Operating Supply Current	Icc		-	11	17	75-7	11	17	mA
V <sub>cc</sub> Zener Voltage	V.,	$I_{cc} = 25\text{mA}$	30	35	15.	30	35	HILIDORN	٧

- Notes: 2. These parameters, although guaranteed, are not 100% tested in production.
  - 3. Parameter measured at trip point of latch with  $V_{FB} = 0$ .
  - 4. Gain defined as:  $A = \frac{\Delta V_{COMP}}{\Delta V_{ISENSE}}$ ;  $0 \le V_{ISENSE} \le 0.8V$
  - 5. Adjust  $V_{cc}$  above the start threshold before setting at 15V.
  - Output frequency equals oscillator frequency for the LX1552 and LX1553. Output frequency is one half oscillator frequency for the LX1554 and LX1555.
- Temperature stability, sometimes referred to as average temperature coefficient, is described by the equation:

Temp Stability = 
$$\frac{V_{REF} \text{ (max.)} - V_{REF} \text{ (min.)}}{T_{A} \text{ (max.)} - T_{A} \text{ (min.)}}$$

 $V_{\rm REF}$  (max.) &  $V_{\rm REF}$  (min.) are the maximum & minimum reference voltage measured over the appropriate temperature range. Note that the extremes in voltage do not necessarily occur at the extremes in temperature.



- \*  $V_{cc}$  and  $V_{c}$  are internally connected for 8 pin packages.
- \*\* POWER GROUND and GROUND are internally connected for 8 pin packages.
- \*\*\* Toggle flip flop used only in 1554 and 1555.



# **ULTRA-LOW START-UP CURRENT, CURRENT-MODE PWM**

PRODUCTION DATA SHEET

## **GRAPH / CURVE INDEX**

#### **Characteristic Curves**

#### FIGURE # DATASET BY TEDYO VIEW MERANXAM

- 1. OSCILLATOR FREQUENCY vs. TIMING RESISTOR
- 2. MAXIMUM DUTY CYCLE vs. TIMING RESISTOR
- 3. OSCILLATOR DISCHARGE CURRENT vs. TEMPERATURE
- 4. OSCILLATOR FREQUENCY vs. TEMPERATURE
- 5. OUTPUT INITIAL ACCURACY vs. TEMPERATURE
- 6. OUTPUT DUTY CYCLE vs. TEMPERATURE
- 7. REFERENCE VOLTAGE vs. TEMPERATURE
- 8. REFERENCE SHORT CIRCUIT CURRENT vs. TEMPERATURE
- 9. E.A. INPUT VOLTAGE vs. TEMPERATURE
- 10. START-UP CURRENT vs. TEMPERATURE
- 11. START-UP CURRENT vs. SUPPLY VOLTAGE
- 12. START-UP CURRENT vs. SUPPLY VOLTAGE
- 13. DYNAMIC SUPPLY CURRENT vs. OSCILLATOR FREQUENCY
- 14. CURRENT SENSE DELAY TO OUTPUT vs. TEMPERATURE
- 15. CURRENT SENSE THRESHOLD vs. ERROR AMPLIFIER OUTPUT
- 16. START-UP THRESHOLD vs. TEMPERATURE
- 17. START-UP THRESHOLD vs. TEMPERATURE
- 18. MINIMUM OPERATING VOLTAGE vs. TEMPERATURE
- 19. MINIMUM OPERATING VOLTAGE vs. TEMPERATURE
- 20. LOW LEVEL OUTPUT SATURATION VOLTAGE DURING UNDER-VOLTAGE LOCKOUT
- 21. OUTPUT SATURATION VOLTAGE vs. OUTPUT CURRENT and TEMPERATURE
- 22. OUTPUT SATURATION VOLTAGE vs. OUTPUT CURRENT and TEMPERATURE

### FIGURE INDEX

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- 24. REFERENCE VOLTAGE vs. TEMPERATURE
- 25. SIMPLIFIED SCHEMATIC OF OSCILLATOR SECTION
- 26. DUTY CYCLE VARIATION vs. DISCHARGE CURRENT
- 27. OSCILLATOR FREQUENCY vs. TIMING RESISTOR
- 28. MAXIMUM DUTY CYCLE vs. TIMING RESISTOR
- 29. CURRENT SENSE THRESHOLD VS. ERROR AMPLIFIER OUTPUT

## **Typical Applications Section**

#### FIGURE #

- 30. CURRENT SENSE SPIKE SUPPRESSION
- 31. MOSFET PARASITIC OSCILLATIONS
- 32. ADJUSTABLE BUFFERED REDUCTION OF CLAMP LEVEL WITH SOFT-START
- 33. EXTERNAL DUTY CYCLE CLAMP AND MULTI-UNIT SYCHRONIZATION
- 34. SLOPE COMPENSATION
- 35. OPEN LOOP LABORATORY FIXTURE
- 36. OFF-LINE FLYBACK REGULATOR

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FIGURE 1. — OSCILLATOR FREQUENCY vs. TIMING RESISTOR

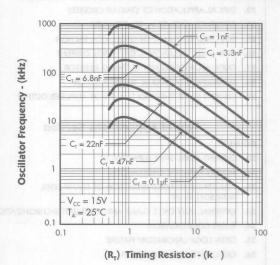


FIGURE 3. — OSCILLATOR DISCHARGE CURRENT vs.
TEMPERATURE

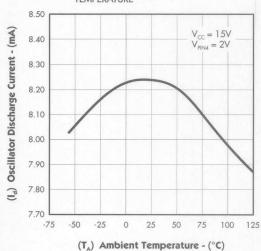


FIGURE 2. — MAXIMUM DUTY CYCLE vs. TIMING RESISTOR

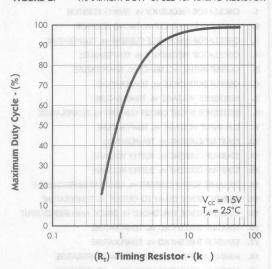
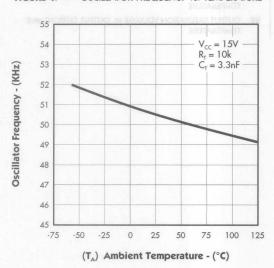


FIGURE 4. — OSCILLATOR FREQUENCY vs. TEMPERATURE



## ULTRA-LOW START-UP CURRENT, CURRENT-MODE PWM

PRODUCTION DATA SHEET

FIGURE 5. — OUTPUT INITIAL ACCURACY vs. TEMPERATURE

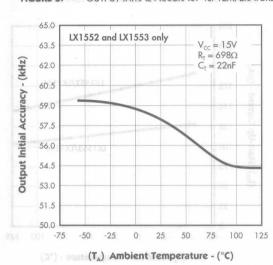


FIGURE 6. — OUTPUT DUTY CYCLE vs. TEMPERATURE

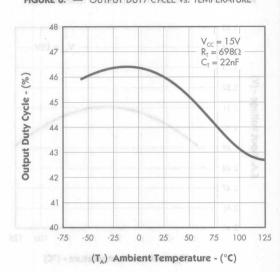


FIGURE 7. — REFERENCE VOLTAGE VS. TEMPERATURE

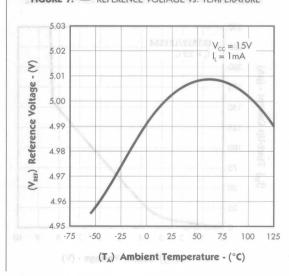
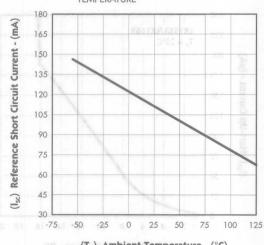


FIGURE 8. — REFERENCE SHORT CIRCUIT CURRENT vs. TEMPERATURE



# **ULTRA-LOW START-UP CURRENT, CURRENT-MODE PWM**

### PRODUCTION DATA SHEET

FIGURE 9. — E.A. INPUT VOLTAGE vs. TEMPERATURE

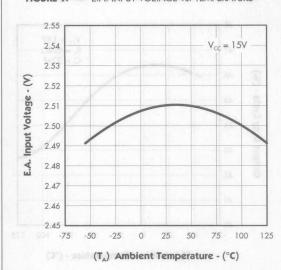


FIGURE 10. — START-UP CURRENT VS. TEMPERATURE

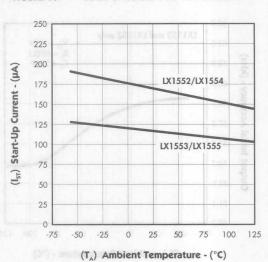


FIGURE 11. — START-UP CURRENT vs. SUPPLY VOLTAGE

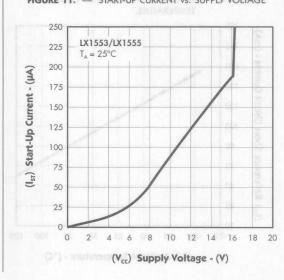
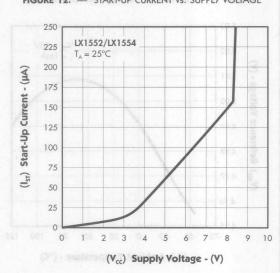


FIGURE 12. — START-UP CURRENT vs. SUPPLY VOLTAGE





# ULTRA-LOW START-UP CURRENT, CURRENT-MODE PWM

PRODUCTION DATA SHEET

#### CHARACTERISTIC CURVES

FIGURE 13. — DYNAMIC SUPPLY CURRENT vs.

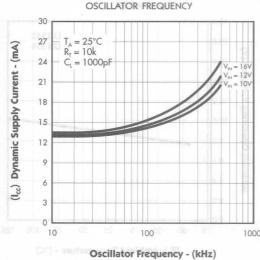
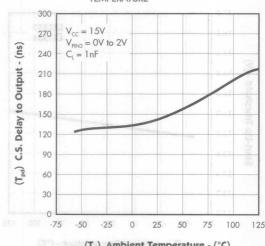
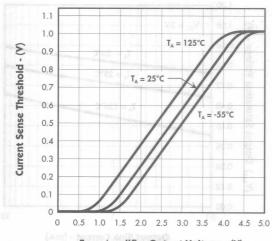


FIGURE 14. — CURRENT SENSE DELAY TO OUTPUT vs. **TEMPERATURE** 



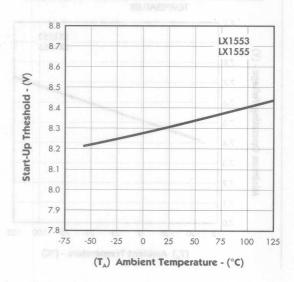
(T<sub>A</sub>) Ambient Temperature - (°C)

FIGURE 15. — CURRENT SENSE THRESHOLD vs. ERROR AMPLIFIER OUTPUT



Error Amplifier Output Voltage - (V)

## FIGURE 16. — START-UP THRESHOLD VS. TEMPERATURE





# ULTRA-LOW START-UP CURRENT, CURRENT-MODE PWM

PRODUCTION DATA SHEET

## CHARACTERISTIC CURVES

FIGURE 17. — START-UP THRESHOLD VS. TEMPERATURE

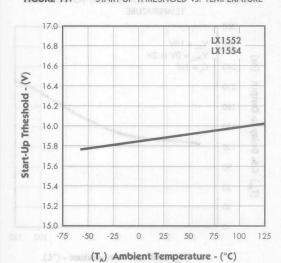


FIGURE 18. — MINIMUM OPERATING VOLTAGE Vs.

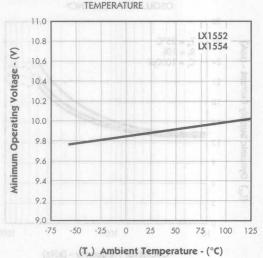


FIGURE 19. — MINIMUM OPERATING VOLTAGE vs.

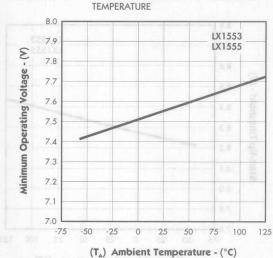
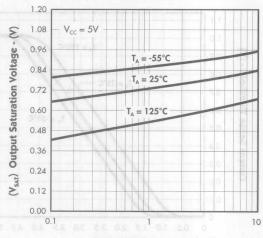


FIGURE 20. — LOW LEVEL OUTPUT SATURATION YOLTAGE DURING UNDER-VOLTAGE LOCKOUT



Output Sink Current - (mA)



## ULTRA-LOW START-UP CURRENT, CURRENT-MODE PWM

PRODUCTION DATA SHEET

## CHARACTERISTIC CURVES

FIGURE 21. — OUTPUT SATURATION VOLTAGE vs.
OUTPUT CURRENT and TEMPERATURE

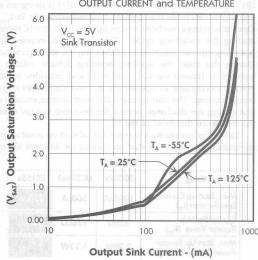
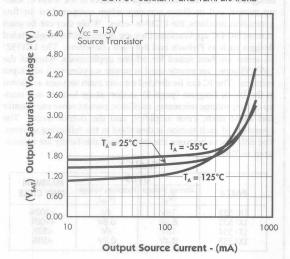


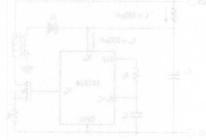
FIGURE 22. — OUTPUT SATURATION VOLTAGE vs.
OUTPUT CURRENT and TEMPERATURE



(Resistor R1 is designed such that it provides 2.5 massi state-up current under low line conditions. Maximum pi dissipation is calculated under maximum line conditions.

un-up resistor. This is especially important in off-line polyppies which are designed to operate for unwested in obages of 90 to 265V AC.

Figure 3.1 shows an efficient supply voltage using the altra latency curve of the LX1551 in conjunction with a lebots midding rat of the power transformer. Cityuit operation of laws.



## **ULTRA-LOW START-UP CURRENT, CURRENT-MODE PWM**

## PRODUCTION DATA SHEET

#### THEORY OF OPERATION

#### IC DESCRIPTION

The LX1552/3/4/5 series of current mode PWM controller IC's are designed to offer substantial improvements in the areas of startup current and oscillator accuracy when compared to the first generation products, the UC184x series. While they can be used in most DC-DC applications, they are optimized for single-ended designs such as Flyback and Forward converters. The LX1552/54 series are best suited for off-line applications, whereas the 1553/55 series are mostly used in power supplies with low input voltages. The IC can be divided into six main sections as shown in the Block Diagram (page 4): undervoltage lockout and startup circuit; voltage reference; oscillator; current sense comparator and PWM latch; error amplifier; and the output stage. The operation of each section is described in the following sections. The differences between the members of this family are summarized in Table 1.

TABLE 1

		17-48		
F	3 63	U	/LO	MAXIMUM
	PART#	Start-up Voltage (V <sub>ST</sub> )	Hysterises Voltage (V <sub>HYS</sub> )	DUTY CYCLE
001	LX1552 LX1553 LX1554 LX1555	16V 8.4V 16V 8.4V	6V 0.8V 6V 0.8V	<100% <100% <50% <50%

#### UNDERVOLTAGE LOCKOUT

The LX155x undervoltage lock-out is designed to maintain an ultra low quiescent current of less than 250 $\mu$ A, while guaranteeing the IC is fully functional before the output stage is activated. Comparing this to the SG384x series, a 4x reduction in start-up current is achieved resulting in 75% less power dissipation in the start-up resistor. This is especially important in off-line power supplies which are designed to operate for universal input voltages of 90 to 265V AC.

Figure 23 shows an efficient supply voltage using the ultra low start-up current of the LX1554 in conjunction with a bootstrap winding off of the power transformer. Circuit operation is as follows.

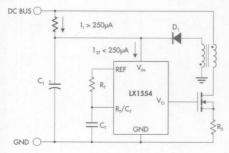


FIGURE 23 — TYPICAL APPLICATION OF START-UP CIRCUITRY

The start-up capacitor (C1) is charged by current through resistor (R1) minus the start-up current. Resistor (R1) is designed such that it provides more than 250µA of current (typically 2x  $I_{_{ST(max)}}$ ). Once this voltage reaches the start-up threshold, the IC turns on, starting the switching cycle. This causes an increase in IC operating current, resulting in discharging the start-up capacitor. During this time, the auxiliary winding flyback voltage gets rectified & filtered via (D1) and (C1) and provides sufficient voltage to continue to operate the IC and support its required supply current. The start-up capacitor must be large enough such that during the discharge period, the bootsrap voltage exceeds the shutdown threshold of the IC.

Table 2 below shows a comparison of start-up resistor power dissipation vs. maximum start-up current for different devices.

	TABLE 2		
Design Using	SG384x	UC384xA	LX155x
Max. Start-up Current Specification (I <sub>ST</sub> )	1000μΑ	500µA	250µA
Typical Start-Up Resistor Value (R <sub>ST</sub> )	62ΚΩ	124ΚΩ	248ΚΩ
Max. Start-Up Resistor Power Dissipation (P <sub>R</sub> )	2.26W	1.13W	0.56W

(Resistor R1 is designed such that it provides 2X maximum start-up current under low line conditions. Maximum power dissipation is calculated under maximum line conditions. Example assumes 90 to 265VAC universal input application.)



## ULTRA-LOW START-UP CURRENT, CURRENT-MODE PWM

## PRODUCTION DATA SHEET

#### THEORY OF OPERATION

#### **VOLTAGE REFERENCE**

The voltage reference is a low drift bandgap design which provides +5.0V to supply charging current to the oscillator timing capacitor, as well as supporting internal circuitries. Initial accuracy for all devices are specified at ±1% max., which is a 2x improvement for the commercial product when compared to the SG384x series. The reference is capable of providing in excess of 20mA for powering any external control circuitries and has built-in short circuit protection.

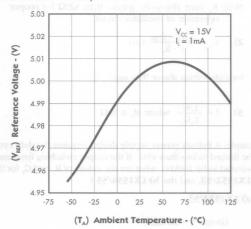


FIGURE 24 — REFERENCE VOLTAGE vs. TEMPERATURE

#### **OSCILLATOR**

The oscillator circuit is designed such that discharge current and valley voltage are trimmed independently. This results in more accurate initial oscillator frequency and maximum output duty cycle, especially important in LX1552/53 applications. The oscillator is programmed by the values selected for the timing components (R<sub>x</sub>) and (C<sub>x</sub>). A simplified schematic of the oscillator is shown in Figure 25. The operation is as follows; Capacitor (C,) is charged from the 5V reference thru resistor (R\_) to a peak voltage of 2.7V nominally. Once the voltage reaches this threshold, comparator (A1) changes state, causing (S1) to switch to position (2) and (S2) to (V<sub>v</sub>) position. This will allow the capacitor to discharge with a current equal to the difference between a constant discharge current (Ip) and current through charging resistor (Ip), until the voltage drops down to 1V nominally and the comparator changes state again, repeating the cycle. Oscillator charge time results in the output to be in a high state (on time) and discharge time sets it to a low state (off time). Since the oscillator period is the sum of the charge and discharge time, any variations in either of them will ultimately affect stability of the output frequency and the maximum duty cycle. In fact, this

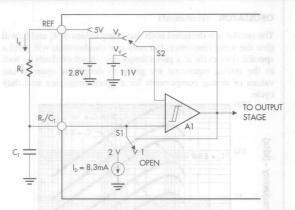


FIGURE 25 — SIMPLIFIED SCHEMATIC OF OSCILLATOR SECTION

variation is more pronounced when maximum duty cycle has to be limited to 50% or less. This is due to the fact that for longer output off time, capacitor discharge current  $(I_{\rm D}-I_{\rm R})$  must be decreased by increasing  $I_{\rm R}$ . Consequently, this increases the sensitivity of the frequency and duty cycle to any small variations of the internal current source  $(I_{\rm D})$ , making this parameter more critical under those conditions. Because this is a desired feature in many applications, this parameter is trimmed to a nominal current value of  $8.3\pm0.3{\rm mA}$  at room temperature, and guaranteed to a maximum range of 7.8 to  $8.8{\rm mA}$  over the specified ambient temperature range. Figure 26 shows variation of oscillator duty cycle versus discharge current for LX155x and SG384x series devices.

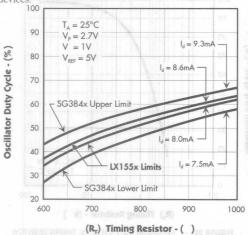


FIGURE 26 — DUTY CYCLE VARIATION vs. DISCHARGE CURRENT

# **ULTRA-LOW START-UP CURRENT, CURRENT-MODE PWM**

## PRODUCTION DATA SHEET

#### THEORY OF OPERATION

#### OSCILLATOR (continued)

The oscillator is designed such that many values of  $R_{\tau}$  and  $C_{\tau}$  will give the same frequency, but only one combination will yield a specific duty cycle at a given frequency. A set of charts as well as the timing equations are given to determine approximate values of timing components for a given frequency and duty cycle.

cycle. 1000  $C_1 = 6.8 \text{nF}$  100  $C_7 = 6.8 \text{nF}$   $C_7 = 3.3 \text{nF}$  100  $C_7 = 6.8 \text{nF}$   $C_7 = 22 \text{nF}$ 

(R<sub>r</sub>) Timing Resistor - (k )

FIGURE 27 — OSCILLATOR FREQUENCY vs. TIMING RESISTOR

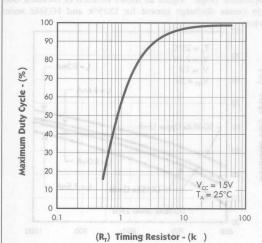


FIGURE 28 — MAXIMUM DUTY CYCLE vs. TIMING RESISTOR

Given: frequency ≅ f; maximum duty-cycle ≅ Dm

1) 
$$R_{\tau} = 277 \left[ \frac{(1.74)^{\frac{1}{Dm}} - 1}{(1.74)^{\frac{1-Dm}{Dm}} - 1} \right] (\Omega), 0.3 \le Dm \le 0.95$$

Note:  $\boldsymbol{R}_{\!_{T}}$  must always be greater than  $520\Omega$  for proper operation of oscillator circuit.

2) 
$$C_T = \frac{1.81 * Dm}{f * R_T}$$
 (µf)

for duty cycles above 95% use:

3) 
$$f \approx \frac{1.81}{R_T C_T}$$
 where  $R_T \ge 5k\Omega$ 

Example: A flyback power supply design requires the duty cycle to be limited to less than 45%. If the output switching frequency is selected to be 100kHz, what are the values of  $R_{\tau}$  and  $C_{\tau}$  for the **a)** LX1552/53, and the **b)** LX1554/55?

# a) LX1552/53

Given: f = 100kHz Dm = 0.45

$$R_{T} = 267 \begin{bmatrix} \frac{1}{.45} & \frac{1}{.45} \\ \frac{.55}{.(1.74)} & -1 \end{bmatrix} = 669\Omega$$

$$C_{\rm T} = \frac{1.81 * 0.45}{100 \times 10^3 * 669} = .012 \,\mu {\rm f}$$

#### b) LX1554/55

 $f_{\rm OUT} = \frac{1}{2} f_{\rm OSC}$  (due to internal flip flop)  $f_{\rm OSC} = 200 {\rm kHz}$ 

select  $C_T = 1000 pf$ using Figure 27 or Equation 3:  $R_T = 9.1 k$ 

# **ULTRA-LOW START-UP CURRENT, CURRENT-MODE PWM**

### PRODUCTION DATA SHEET

#### THEORY OF OPERATION

#### **CURRENT SENSE COMPARATOR AND PWM LATCH**

Switch current is sensed by an external sense resistor (or a current transformer), monitored by the C.S. pin and compared internally with voltage from error amplifier output. The comparator output resets the PWM latch ensuring that a single pulse appears at the output for any given oscillator cycle. The LX1554/55 series has an additional flip flop stage that limits the output to less than 50% duty cycle range as well as dividing its output frequency to half of the oscillator frequency. The current sense comparator threshold is internally clamped to 1V nominally which would limit peak switch current to:

(1) 
$$I_{SP} = \frac{V_Z}{R_S}$$
 where:  $I_{SP} \equiv \text{Peak switch current}$   $V_Z \equiv \text{internal zener}$   $0.9V \leq V_Z \leq 1.1V$ 

Equation 1 is used to calculate the value of sense resistor during the current limit condition where switch current reaches its maximum level. In normal operation of the converter, the relationship between peak switch current and error voltage (voltage at pin 1) is given by:

(1) 
$$I_{sp} = \frac{V_E - 2V_F}{3 * R_s}$$
 where:  $V_E \equiv Voltage \text{ at pin 1}$ 

$$V_F \equiv Diode - Forward \text{ voltage}$$
0.7V at T, = 25°C

The above equation is plotted in Figure 29. Notice that the gain becomes non-linear above current sense voltages greater than  $\approx$  0.95 volts. It is therefore recommended to operate below this range during normal operation. This would insure that the overall closed loop gain of the system will not be affected by the change in the gain of the current sense stage.

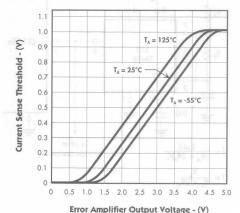


FIGURE 29 — CURRENT SENSE THRESHOLD VS. ERROR AMPLIFIER OUTPUT

#### ERROR AMPLIFIER

The error amplifier has a PNP input differential stage with access to the Inverting input and the output pin. The N.I. input is internally biased to 2.5 volts and is not available for any external connections. The maximum input bias current for the LX155XC series is  $0.5\mu A$ , while LX155XI/155XM devices are rated for  $1\mu A$  maximum over their specified range of ambient temperature. Low value resistor dividers should be used in order to avoid output voltage errors caused by the input bias current. The error amplifier can source 0.5mA and sink 2mA of current. A minimum feedback resistor ( $R_p$ ) value of is given by:

$$R_{\text{FMIN}} = \frac{3(1.1) + 1.8}{0.5 \text{mA}} \approx 10 \text{K}$$

#### **OUTPUT STAGE**

The output section has been specifically designed for direct drive of power MOSFETs. It has a totempole configuration which is capable of high peak current for fast charging and discharging of external MOSFET gate capacitance. This typically results in a rise and fall time of 50ns for a 1000pf capacitive load. Each output transistor (source and sink) is capable of supplying 200mA of continuous current with typical saturation voltages versus temperature as shown in Figures 21 & 22 of the characteristic curve section. All devices are designed to minimize the amount of shoot-thru current which is a result of momentary overlap of output transistors. This allows more efficient usage of the IC at higher frequencies, as well as improving the noise susceptibility of the device. Internal circuitry insures that the outputs are held off during  $V_{\rm CC}$  ramp-up. Figure 20, in the characteristic curves section, shows output sink saturation voltage vs. current at 5V.



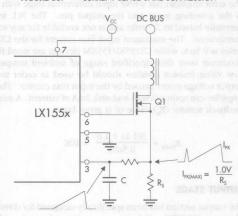
# ULTRA-LOW START-UP CURRENT, CURRENT-MODE PWM

#### PRODUCTION DATA SHEET

#### TYPICAL APPLICATION CIRCUITS

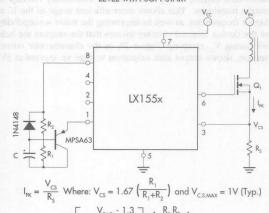
Unless otherwise specified, pin numbers refer to 8-pin package.

FIGURE 30. — CURRENT SENSE SPIKE SUPPRESSION



The RC low pass filter will eliminate the leading edge current spike caused by parasitics of Power MOSFET.

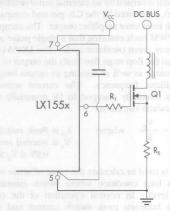
FIGURE 32. — ADJUSTABLE BUFFERED REDUCTION OF CLAMP
LEVEL WITH SOFT-START



where; V<sub>EAO</sub> ≡ voltage at the Error Amp Output under minimum line and maximum load conditions.

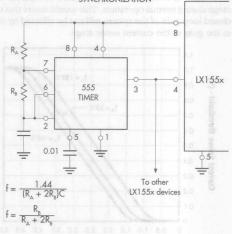
Soft start and adjustable peak current can be done with the external circuitry shown above.

FIGURE 31. — MOSFET PARASITIC OSCILLATIONS



A resistor ( $R_1$ ) in series with the MOSFET gate reduces overshoot & ringing caused by the MOSFET input capacitance and any inductance in series with the gate drive. (Note: It is very important to have a low inductance ground path to insure correct operation of the I.C. This can be done by making the ground paths as short and as wide as possible.)

FIGURE 33. — EXTERNAL DUTY CYCLE CLAMP AND MULTI-UNIT SYNCHRONIZATION



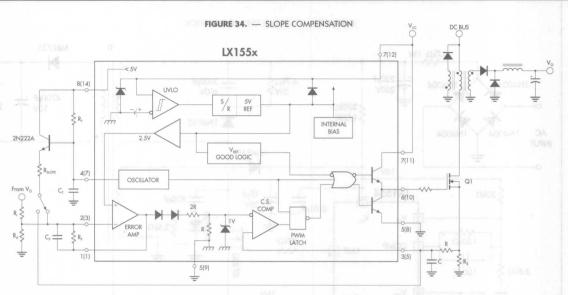
Precision duty cycle limiting as well as synchronizing several parts is possible with the above circuitry.



## ULTRA-LOW START-UP CURRENT, CURRENT-MODE PWM

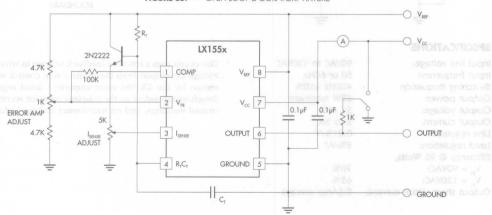
## PRODUCTION DATA SHEET

## TYPICAL APPLICATION CIRCUITS (continued)



Due to inherent instability of fixed frequency current mode converters running above 50% duty cycle, slope compensation should be added to either the current sense pin or the error amplifier. Figure 34 shows a typical slope compensation technique. Pin numbers inside parenthesis refer to 14-pin package.

FIGURE 35. — OPEN LOOP LABORATORY FIXTURE

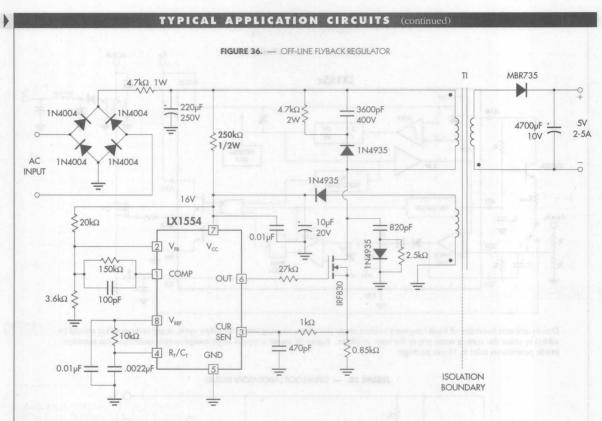


High peak currents associated with capacitive loads necessitate careful grounding techniques. Timing and bypass capacitors should be connected to pin 5 in a single point ground. The transistor and 5k potentiometer are used to sample the oscillator waveform and apply an adjustable ramp to pin 3.



# ULTRA-LOW START-UP CURRENT, CURRENT-MODE PWM

#### PRODUCTION DATA SHEET



#### **SPECIFICATIONS**

Input line voltage:
Input frequency:
Switching frequency:
Output power:
Output voltage:
Output current:
Line regulation:
Load regulation:
Efficiency @ 25 Watts,
V<sub>IN</sub> = 90VAC:

 $V_{IN} = 130VAC$ :

Output short-circuit current:

90VAC to 130VAC 50 or 60Hz 40KHz ±10% 25W maximum 5V +5% 2 to 5A 0.01%/V 8%/A\*

65% 2.5Amp average \* This circuit uses a low-cost feedback scheme in which the DC voltage developed from the primary-side control winding is sensed by the LX1554 error amplifier. Load regulation is therefore dependent on the coupling between secondary and control windings, and on transformer leakage inductance.



## Second-Generation Power Factor Controller

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

The LX1562 is a second-generation family of power factor correction controllers using a discontinuous mode of operation. They are optimized for electronic ballast applications. Many improvements have been made over the original SG3561A controller introduced by Silicon General Semiconductor in 1992.

New features include the addition of an internal start-up circuit eliminating bulky external components while allowing independent boost converter operation. Addition of internal current sense blanking eliminating the need for an external R/C filter network. Internal clamping of the error amplifier and multiplier outputs improves turn on overshoot characteristics and current limiting. Special circuitry has also been

added to prevent no load runaway conditions. And finally, output drive clamps limiting power MOSFET gate drive independent of supply voltage greatly enhance the products practical application.

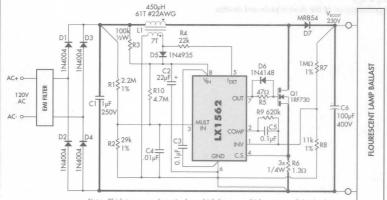
Although the IC design has been optimized for electronic ballast applications, it can also be used for power factor correction in lower power (typ < 300W) AC-DC converters. One unique feature of the device is encompassed by the addition of internal logic circuitry to detect zero crossing of the inductor current thus maintaining the discontinuous current mode of operation. This feature prevents large current gaps from appearing thereby minimizing distortion and enhancing power factor correction.

#### KEY FEATURES

- INTERNAL START-UP CIRCUIT
- **INTERNAL CURRENT SENSE BLANKING**
- IMPROVED MICROPOWER START-UP CURRENT (300µA max.)
- CLAMPED E.A. OUTPUT FOR LOWER TURN-ON OVERSHOOT
- MULTIPLIER CLAMP LIMITS MAXIMUM INPUT CURRENT
- INTERNAL OVERVOLTAGE PROTECTION REPLACES BUILT-IN C.S. OFFSET
- PWM OUTPUT CLAMP LIMITS MOSFET GATE DRIVE VOLTAGE
- INCREASED UVLO HYSTERESIS REDUCES
  START-UP TIMING (LX1562 only)
- LOW OPERATING CURRENT CONSUMPTION
- INTERNAL 1.5% REFERENCE
- TOTEM POLE OUTPUT STAGE
- AUTOMATIC CURRENT LIMITING OF BOOST STAGE
- DISCONTINUOUS MODE OF OPERATION WITH NO CURRENT GAPS
- NO SLOPE COMPENSATION REQUIRED

#### PRODUCT HIGHLIGHT

Typical Application of the LX1562 in an 80W Fluorescent Lamp Ballast with Active Power Factor Control



Note: Thick trace on schematic shows high-frequency, high-current path in circuit.

Lead lengths must be minimized to avoid high-frequency noise problems.

#### APPLICATIONS

- ELECTRONIC BALLAST
- SWITCHING POWER SUPPLIES

AVAILABLE	OPTIONS	PER PART	7
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Part #	Start-Up Voltage	Hysteresis Voltage
LX1562	13.1V	5.2V
LX1563	9.8V	2.1V

#### PACKAGE ORDER INFORMATION

T <sub>A</sub> (°C)	M Plastic DIP 8-pin	DM Plastic SOIC 8-pin
0 to 100	LX1562IM	LX1562IDM
0 to 100	LX1563IM	LX1563IDM

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX1562IDMT)

FOR FURTHER INFORMATION CALL (714) 898-8121

# SECOND-GENERATION POWER FACTOR CONTROLLER

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## PRODUCTION DATA SHEET

RECOMMENDED OPER	ATING C	DNDITION	<b>S</b> (Note 4)		
Parameter	Symbol	Recommend	Conditions	Units	
Faidilletei	Symoon	Min.	Тур.	Max.	Oilite
Supply Voltage Range		11	REPORT TOTAL	25	V
Peak Driver Output Current	May May	Law 2 WO and	±200	Install to	mA
Operating Ambient Temperature Range:	I NO DELL'ARTE	- was 1		Sicresic Dickey to El	Curren
LX1562/1563		0		100	°C .

Note 4. Range over which the device is functional.

## ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the LX1562/1563 with 0°C  $\leq$  T<sub>A</sub>  $\leq$  100°C; V<sub>PS</sub>=12V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Cumbal	Test Conditions	LX	15621/15	631	Units
Parameter	Symbol	lest conditions	Min.	Тур.	Max.	Units
<b>Under-Voltage Lockout Section</b>						
Start Threshold Voltage	V <sub>ST</sub>	LX1562 Only	12	13.1	14	٧
		LX1563 Only	9.2	9.8	10.6	٧
UV Lockout Hysteresis	$\Delta V_{H}$	LX1562 Only	4	5.2	6	V
V 8.0		LX1563 Only	1.7	2.1	2.5	V
Supply Current Section						
Start-Up Supply Current	I <sub>ST</sub>	V <sub>IN</sub> < V <sub>TH</sub>		200	300	μА
Operating Supply Current	I <sub>o</sub>	V <sub>IN</sub> = 12V, Output Not Switching		5	8	mA
Dynamic Operating Supply Current	lop	V <sub>IN</sub> = 12V, 50kHz, CGS = 1000pF		6	10	mA
Reference Section (Note 5)		and always for Ill a spatial paracess only.	number of bearing	cicus su	They	
Initial Accuracy (Note 8)	V <sub>R</sub>	I <sub>REF</sub> = 0mA, T <sub>A</sub> = 25°C	2.465	2.50	2.535	٧
		I <sub>RFF</sub> = OmA	2.44	57 50	2.56	V
Line Regulation	$\Delta V_{I}$	12V < V <sub>IN</sub> < 25V		0.1		mV
Load Regulation	$\Delta V_L$	$0 < I_{REF} < 2mA$	The second second second	1.3		mV
Temperature Stability	$\Delta V_{T}$			20		mV
Error Amplifier Section						
Input Bias Current	I <sub>B</sub>		-500	50	500	nA
Large Signal Open Loop Voltage Gain	A <sub>VOL</sub>	(Note 5)	60	80		dB
Slew Rate	S			0.63		V/µsec
Power Supply Rejection Ratio (Note 5)	PSRR	11 to 25V	60	80		dB
Output Source Current	I <sub>SR</sub>	V <sub>OH</sub> = 3V	-2	-4.5		mA
Output Sink Current	I <sub>sk</sub>	V <sub>OL</sub> = 2V	3	4.5		mA
Output Voltage Range (Note 7)	E.A.	No Load on E.A. Output	1.2		3.8	V
Unity Gain Bandwidth	f <sub>B</sub>			1.7		MHz
Phase Margin	фв			49		0
Multiplier Section						
Mult. Input Voltage Range	V <sub>M1</sub>		0		2	V
M2 Input Voltage Range	V <sub>M2</sub>		V <sub>RFF</sub>		V <sub>RFF</sub> + 1	٧
Mult. Input Bias Current (M1)	I <sub>MB</sub>		AL.	-0.24	KEI	μА
Multiplier Gain (Note 5 & 6)	K	$V_{M1} = 1V, \Delta V_{EA0} = 2.7V \text{ to } 3.3V$	0.55	0.68	0.8	V/V2
		$\Delta V_{M1} = 0.5 \text{V to } 1.5 \text{V}, V_{EA0} = V_{REF} + 1 \text{V}$	0.55	0.61	0.75	V/V <sup>2</sup>
Multiplier Gain Temperature Stability	$\Delta K_{T}$			-0.2		%/°C
Maximum Multiplier Output Voltage	V <sub>CLMP</sub>	$V_{M1} = 2V, V_{PIN1} = 0V$	1.1	1.24	1.45	٧

(Electrical Characteristics continue next page.)

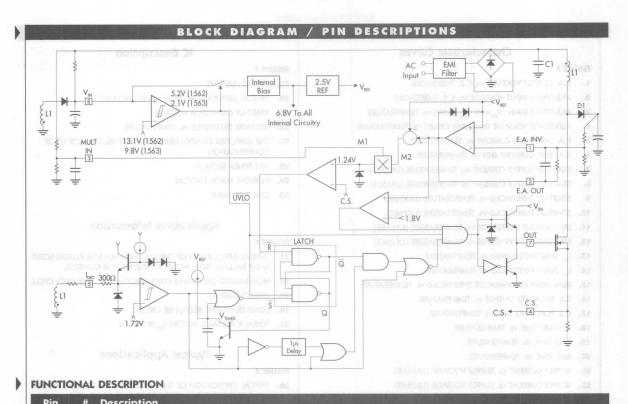


# SECOND-GENERATION POWER FACTOR CONTROLLER

# PRODUCTION DATA SHEET

Parameter		C		4 Candisiana	THE RES		LX1	5621/15	631	Hei	
		Symbol	Symbol Test Conditions				Min.	Тур.	units		
Current Sens	e Comp	arator Sec	ction								
Input Bias Curre	ent	0024	I <sub>CSB</sub>	$0V \le V_{CS} \le 1.7V$				-1 ::::::	-0.3	JO TVIC	µ/
Current Sense [	Delay to (	Output	t <sub>d</sub>	E.A. <sub>OUT</sub> = 3.7V, V <sub>cs</sub> =	= 0 to 1.2V, $V_{M1} = 1V$		Sprial of	(tristage	280	500	a ns
C.S. Blanking Tir	me		t <sub>BLK</sub>	6 1 1				0.4	0.9	1.2	μs
C.S. Input Offse	et Voltage	:	V <sub>OFF</sub>	$V_{EA0} = 2.2V, V_{M1} = 0$	IV, I <sub>DETC</sub> = OV	Lande Link	u continu	-20	3	20	m'
Detect Section	on		011	CAO MI	, perc						
Input Voltage TI	hreshold	- High	V <sub>HI</sub>		A STATE OF THE STA	NAME OF TAXABLE PARTY.	10 2008 P	1.6	1.72	1.9	V
Hysteresis		H			- Wall 1979	July 76.7	180	240	300	m	
Input LO Clamp	Voltage	SPHILE, IZ	V <sub>DI</sub>	I <sub>DET</sub> = 100μA	che apening militerina	No allegate an	1000011 D	0.4	0.62	0.85	V
Input HI Clamp Voltage		V <sub>DZ</sub>	$I_{DET} = 3mA$	mercin between strong to the	tine nouse	all salates in	7.0	7.8	8.6	V	
Input Current	Mana Crit		I <sub>DB</sub>	$1V \le V_{DET} \le 6V$		LINE NAME	THE TRUE IN	-1	-0.2	1	μ/
Input HI/LO Clar	mp Diode	Current	I <sub>DMX</sub>	$V_{DET} < 0.9V, V_{DET} > 6$	V					±3	m
Restart Time			'DMX	DET COLVE, DET		Assessing Control	00.735	2 Jun	alpool as		stanti
Restart Time	13.1	BIT I	t <sub>RST</sub>		LX1569 Only	LIV I			300	plodesnil	use
Output Drive	er Section	on	RST		YMO ESERX!						pioc
Output High Vo		011	V <sub>PRH</sub>	I <sub>L</sub> = -10mA, V <sub>IN</sub> = 19		No.		8.5	9	(Fl Juoda	IV
Output Low Vo	-		V <sub>PRI</sub>	$I_{L} = 10 \text{ mA}, V_{IN} = 12$				0.5	0.8	1	V
Output Rise Tim			t <sub>p</sub>	$C_i = 1000pF$	Y			mak	130	200	n
Output Rise Till			t,	$C_L = 1000pF$	V = V.		-		50	120	
Maximum Outp			V <sub>DRMX</sub>	-		177				15	n V
They a	are guara	inteed by de	ot brought out	externally, these sp wn for illustrative pu	*	obe only, a			notice	ne packaş	ged p
They :	are guara	inteed by de	ot brought out	externally, these sp wn for illustrative pu	ecifications are tested at pro irposes only.	obe only, a		ot be tes	sted on tl	ne packaş	ged pa
They at $6. K = \frac{1}{(2)}$	are guara Δ\ ΔV <sub>M1</sub> ) x (	inteed by de V <sub>C.S.</sub> V <sub>EA0</sub> - V <sub>REF</sub> )	ot brought out esign, and show $\approx \frac{\Delta V_{c.s.}}{(V_{M1}) (\Delta V_{c.s.})}$	externally, these sp wn for illustrative pu	ecifications are tested at pro proses only.	¥		ot be tes	sted on the	ne packaş	ged pa
They at $6. K = \frac{7}{(2)}$	are guara $\Delta V_{M1}$ x (parameter	inteed by de $V_{C.S.}$ $V_{EA0} - V_{REF}$ $V_{REF}$	ot brought out esign, and show $\approx \frac{\Delta V_{C.S.}}{(V_{MI}) (\Delta V)}$ guaranteed, is 1	externally, these spown for illustrative pu	ecifications are tested at pro proses only.	,VA		ot be tes	sted on th	ne packaş	ged pa
They at $6. K = \frac{1}{(2)}$ 7. This p	are guara $\Delta V_{M1}$ x (parameter	inteed by de $V_{C.S.}$ $V_{EA0} - V_{REF}$ $V_{REF}$	ot brought out esign, and show $\approx \frac{\Delta V_{C.S.}}{(V_{MI}) (\Delta V)}$ guaranteed, is 1	externally, these sp wn for illustrative pu	ecifications are tested at pro proses only.	¥		ot be tes	sted on the	ne packaş	ged pa
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They at $6. K = \frac{1}{(2)}$ 7. This p 8. Initial	ΔV <sub>MI</sub> ) x ( parameter accuracy	inteed by development $V_{C.S.}$ $V_{EAO} - V_{REF}$ $V_{r}$ , although go includes in	ot brought out esign, and show $\approx \frac{\Delta V_{C.S.}}{(V_{MI}) (\Delta V)}$ guaranteed, is 1	externally, these spown for illustrative pu	ecifications are tested at pro proses only.	,VA		ot be tes	sted on the	ne packaş	ged po
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They are the following the fo	are guara $\Delta V$ $\Delta V_{M1}$ ) x (  parameter accuracy	inteed by development $V_{C.S.}$ $V_{EAO} - V_{REF}$ $V_{r}$ , although go includes in	ot brought out esign, and show $\approx \frac{\Delta V_{C.S.}}{(V_{MI}) (\Delta V)}$ guaranteed, is 1	externally, these spown for illustrative pu	ecifications are tested at pro proses only.	,VA		not be tes	sted on the	ne packag	ged pa
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They :    6.   K   =   (4)     7. This p     8. Initial	ΔV <sub>M</sub> ) x (  are guara  ΔV <sub>M</sub> ) x (  arameter accuracy	unteed by development of the value of the va	ot brought out esign, and show $\approx \frac{\Delta V_{C.S.}}{(V_{MI}) (\Delta V)}$ guaranteed, is 1	externally, these spown for illustrative pu	ecifications are tested at pro proses only. tion.	,VA		nol	sted on the	packag	ged pa
They :    6. K = (4)     7. This p     8. Initial     An   000     6. K = (4)     7. This p     8. Initial     9. Initial	AV <sub>MI</sub> ) x (  Δν <sub>MI</sub> ) x (  αrameter accuracy	inteed by development $V_{CS}$ , $V_{EAO} - V_{REF}$ , although $g$ $v$ includes in	ot brought out esign, and show $\approx \frac{\Delta V_{C.S.}}{(V_{MI}) (\Delta V)}$ guaranteed, is 1	externally, these spown for illustrative pu	ecifications are tested at prouposes only.  tion. er.	79 766 766 766 766		nol	sted on the	me packag	ged parent of the parent of th
They a 2	ΔV <sub>M</sub> ) x (  are guara  ΔV <sub>M</sub> ) x (  arameter accuracy	inteed by development $V_{CS}$ , $V_{EA0} - V_{REF}$ , although $g_{V}$ includes in	ot brought out esign, and show $\approx \frac{\Delta V_{C.S.}}{(V_{MI}) (\Delta V)}$ guaranteed, is 1	externally, these spown for illustrative pu	ecifications are tested at prouposes only.  tion. er.	79 766 766 766 766		noi	sted on the	package operations of the package operations	ged paged pa
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They a 6. K = (2. 7. This p 8. Initial An 2006	ΔV <sub>M</sub> ) x (corrections)	inteed by development $V_{CS}$ , $V_{EA0} - V_{REF}$ , although $g_{V}$ includes in	ot brought out esign, and show $\approx \frac{\Delta V_{C.S.}}{(V_{MI}) (\Delta V)}$ guaranteed, is 1	externally, these spown for illustrative pu	ecifications are tested at prouposes only.  tion. er.	79 766 766 766 766		noi	sted on the sted o	ne packag	ged pa
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They:    Color   Color	ΔV <sub>M</sub> ) x (corrections)	inteed by development $V_{CS}$ , $V_{EAO} - V_{REF}$ , although $g_{V}$ includes in	ot brought out esign, and show $\approx \frac{\Delta V_{C.S.}}{(V_{MI}) (\Delta V)}$ guaranteed, is 1	externally, these spown for illustrative pu	ecifications are tested at prouposes only.  tion. er.	79 766 766 766 766		noi noi noi noi noi noi	sted on the control of the control o	ne packag	ged paged pa
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They :    25	are guara  AV  AV  AV  AV  AV  AV  AV  AV  AV  A	inteed by determined by $V_{CS}$ , $V_{EAO} - V_{REF}$ , although $g$ includes in	ot brought out esign, and show $\approx \frac{\Delta V_{C.S.}}{(V_{MI}) (\Delta V)}$ guaranteed, is 1	externally, these sp wn for illustrative pu (EAG)  not tested in product age of error amplifie	ecifications are tested at prouposes only.  And	79 766 766 766 766		noi estion () obs9 (	the dotted on the color of the	ne packag  (281020A  notteluga  coleiuga  e source  filliama  mud seld  12 kmg/l  2 kmg/l  2 mailig  lov augml  effortuga  effortuga  alid tugal	Manual Ma
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## PRODUCTION DATA SHEET



Pin	#	Description
V <sub>IN</sub>	8	Input supply voltage.
GND	6	Input supply voltage return. Must always be the lowest potential of all the pins.
INV	1	Inverting input of the Error Amplifier. The output of the Boost converter should be resistively divided to 2.5V and connected to this pin.
E.A. OUT	2	The output of the Error Amplifier. A feedback compensation network is placed between this pin and the INV pin.
MULT IN	3	Input to the multiplier stage. The full-wave rectified AC is divided to less than 2V and is connected to this pin.
C.S.	4	Input to the PWM comparator. Current is sensed in the Boost stage MOSFET by a resistor in the source lead, and is fed to this pin. An internal blanking circuit eliminates the RC low pass filter that otherwise is required to eliminate leading edge spike.
I <sub>DET</sub>	5	A current driven logic input with internal clamp. A second winding on the Boost inductor senses the flyback voltage associated with the zero crossing of the inductor current and feeds it to the $I_{DET}$ pin through a limiting resistor. Low on this pin causes $V_{O}$ (pin 7) to go high.
OUT	7	PWM output pin. A totem-pole output stage specially designed for direct driving the MOSFET.



## SECOND-GENERATION POWER FACTOR CONTROLLER

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- 4. REFERENCE VOLTAGE (Including Offset) vs. TEMPERATURE
- 5. E.A. INPUT BIAS CURRENT VS. TEMPERATURE
- 6. E.A. SINK CURRENT @2V vs. TEMPERATURE
- 7. START-UP SUPPLY CURRENT vs. TEMPERATURE (LX1563)
- 8. START-UP SUPPLY CURRENT vs. TEMPERATURE (LX1562)
- 9. START-UP THRESHOLD vs. TEMPERATURE (LX1562)
- 10. START-UP THRESHOLD vs. TEMPERATURE (LX1563)
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- 12. UV LOCKOUT HYSTERESIS vs. TEMPERATURE (LX1563)
- 13. Inst THRESHOLD HIGH vs. TEMPERATURE
- 14. IDET INPUT HYSTERESIS VS. TEMPERATURE
- 15. RUN-AWAY COMPARATOR THRESHOLD vs. TEMPERATURE
- 16. C.S. DELAY TO OUTPUT vs. TEMPERATURE
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- 24. TYPICAL APPLICATION OF START-UP CIRCUITRY
- 25. START-UP CAPACITOR VOLTAGE
- 26. VOLTAGE REFERENCE vs. TEMPERATURE
- 27. THE AMPLIFIER CONFIGURED AS AN INTEGRATOR FOR LOOP COMPENSATION
- 28. MULTIPLIER SECTION
- 29. CURRENT SENSE SECTION
- 30. START-UP TIMER

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- 31. TYPICAL APPLICATION OF THE LX1562 IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL
- 32. NORMALIZED OPERATING FREQUENCY vs. OFF-TIME DUTY CYCLE
- 33. INDUCT CURRENT
- 34. LOAD TRANSIENT RESPONSE CIRCUIT
- 35. FLYBACK VOLTAGE ACROSS I WINDING

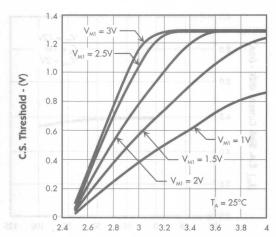
## Typical Applications

#### FIGURE #

- 36. TYPICAL APPLICATION OF THE LX1562 IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL 120V
- 37. TYPICAL APPLICATION OF THE LX1562 IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL 220V
- 38. TYPICAL APPLICATION OF THE LX1562 IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL 277V

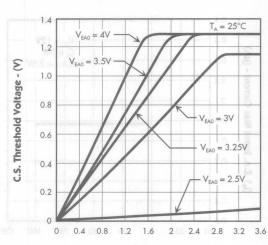
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FIGURE 1. — E.A. OUTPUT VOLTAGE vs. C.S. THRESHOLD



E.A. Output Voltage - (V)

FIGURE 2. — MULTIPLIER INPUT VOLTAGE vs. C.S. THRESHOLD



Multiplier Input Voltage - (V)

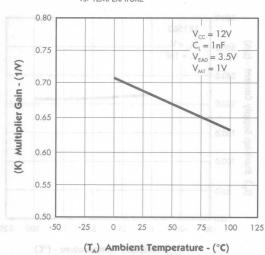
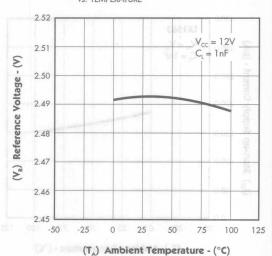


FIGURE 4. — REFERENCE VOLTAGE (Including Offset)
vs. TEMPERATURE



# SECOND-GENERATION POWER FACTOR CONTROLLER

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FIGURE 5. — E.A. INPUT BIAS CURRENT VS. TEMPERATURE

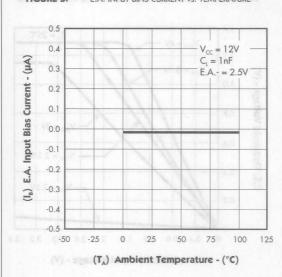


FIGURE 6. — E.A. SINK CURRENT @2V vs. TEMPERATURE

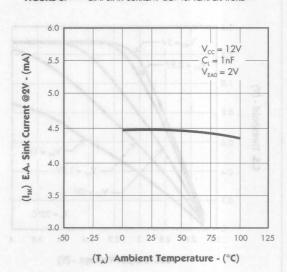


FIGURE 7. — START-UP SUPPLY CURRENT vs. TEMPERATURE

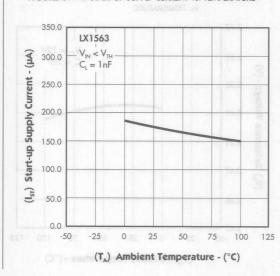
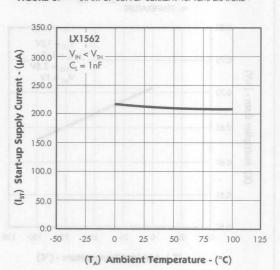


FIGURE 8. — START-UP SUPPLY CURRENT VS. TEMPERATURE





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FIGURE 9. — START-UP THRESHOLD VS. TEMPERATURE

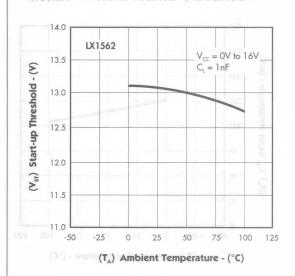


FIGURE 10. — START-UP THRESHOLD vs. TEMPERATURE

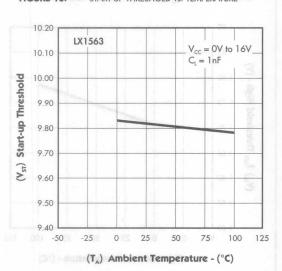


FIGURE 11. — UV LOCKOUT HYSTERESIS vs. TEMPERATURE

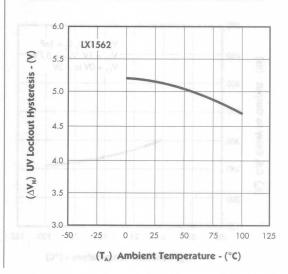
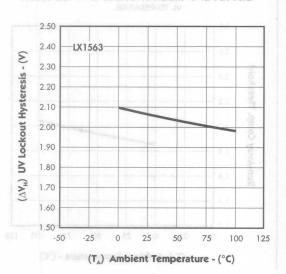


FIGURE 12. — UV LOCKOUT HYSTERESIS vs. TEMPERATURE



# SECOND-GENERATION POWER FACTOR CONTROLLER

PRODUCTION DATA SHEET

FIGURE 13. — IDET THRESHOLD HIGH VS. TEMPERATURE

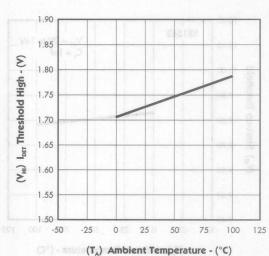


FIGURE 14. — IDET INPUT HYSTERESIS VS. TEMPERATURE

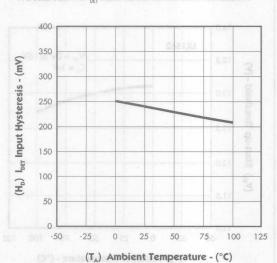


FIGURE 15. — RUN-AWAY COMPARATOR THRESHOLD vs. TEMPERATURE

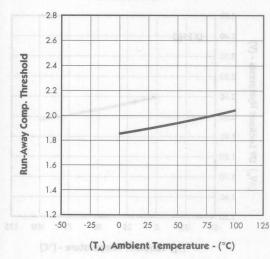
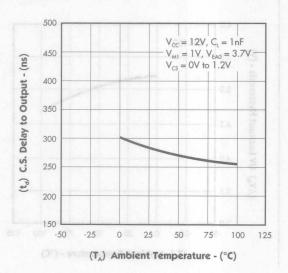


FIGURE 16. — C.S. DELAY TO OUTPUT vs. TEMPERATURE





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FIGURE 17. — C.S. BLANKING TIME VS. TEMPERATURE

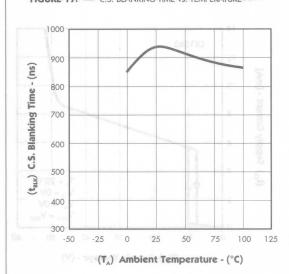


FIGURE 18. — RESTART TIME VS. TEMPERATURE

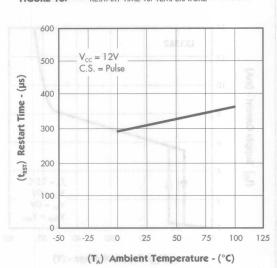


FIGURE 19. — FALL TIME VS. TEMPERATURE

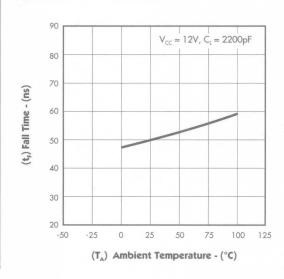
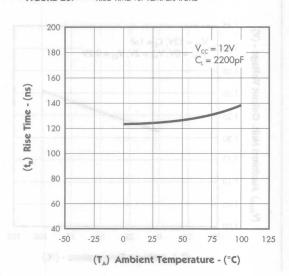


FIGURE 20. — RISE TIME VS. TEMPERATURE



# SECOND-GENERATION POWER FACTOR CONTROLLER

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FIGURE 21. — SUPPLY CURRENT vs. SUPPLY VOLTAGE

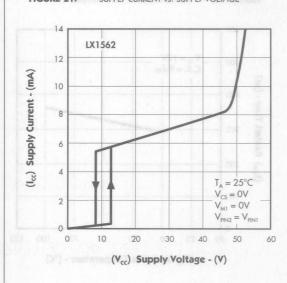


FIGURE 22. — SUPPLY CURRENT VS. SUPPLY VOLTAGE

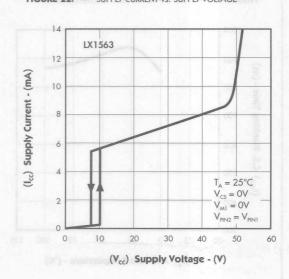
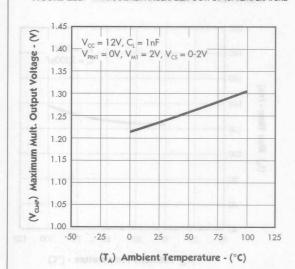


FIGURE 22a. — MAXIMUM MULTIPLIER OUTPUT vs. TEMPERATURE



V<sub>C</sub> = 2V<sub>V</sub> C = 2200pE

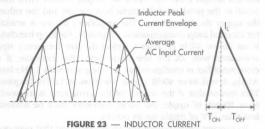


### PRODUCTION DATA SHEET

#### **FUNCTIONAL DESCRIPTION**

The operation of the IC is best described by referring to the block-diagram. The output of the multiplier stage generates a voltage proportional to the product of the rectified AC line and the output of the error amplifier. This voltage serves as the reference for the inductor peak current that is sensed by the resistor in series with the external power MOSFET. When the sense voltage exceeds this threshold, C.S. comparator trips and resets the latch as well as turning the power MOSFET off.

The energy stored during switch on-time is now transferred and stored in the output capacitor, causing the inductor current



to ramp down. When current reaches zero level (inductor runs out of energy), boost diode (D1) stops conducting and the residual inductor energy and the drain to source capacitance of the power MOSFET create an LC tank circuit which causes drain voltage to resonate at this frequency. The resonating voltage is detected by the secondary winding (Idet winding) of the inductor. When this voltage swings negative "I detect" pin senses it and activates the blanking circuit, sets the latch, and turns power MOSFET on, repeating the cycle. This operation continues for the entire cycle of the AC rectified input resulting in an inductor current as shown in Figure 23. The high frequency content of this current is then filtered by the input capacitor (C1) resulting in a sine wave input current in phase with the AC line voltage.

Output voltage regulation is accomplished when the error amplifier compares this voltage to an internal 2.5V reference and generates an error voltage. This voltage then controls the amplitude of the multiplier output adjusting the peak inductor current proportional to the load and line variations, maintaining a well regulated voltage.

#### IC DESCRIPTION

### UNDERVOLTAGE LOCK OUT

The LX1562/63 undervoltage lock-out is designed to maintain an ultra low quiescent current of less than 300 $\mu\text{A}$ , while guaranteeing the IC is fully functional before the output stage is activated. Comparing this to the SG3561A device, a 40% reduction in start-up current is achieved, resulting in 40% less power dissipation in the start-up resistor. This is especially important in electronic ballast applications that are designed to operate in harsh environments, with convection cooling as the only means of heat dissipation.

Figure 24 shows an efficient supply voltage using the ultra low start-up current of the LX1562 in conjunction with a bootstrap winding off of the power transformer. Circuit operation is as follows:

The start-up capacitor (C1) is charged by current through resistor (R1) minus the start-up current drawn by the IC. This resistor is typically chosen to provide 2X the maximum start-up current at low line to guarantee start-up under the worst case condition. Once the capacitor voltage reaches the start-up threshold, the IC turns on, starting the switching cycle. The operation of the IC demands an increase in operating current which results in discharging the capacitor. During the discharge cycle, the flyback voltage of the auxiliary winding is rectified and filtered via rectifier (D1) and charges the capacitor above the minimum operating voltage of the device and takes over as the supply voltage. The start-up capacitor and auxiliary winding must be selected such that it satisfies worst case IC conditions. Figure 25 shows start-up time and voltage of capacitor CI.

Table 1 shows the start-up voltage and hysteresis for LX1562 and LX1563. The LX1562 is used for stand alone pre-regulator applications while LX1563 is ideal for applications where supply voltage is derived elsewhere and requires less than 14V start-up.

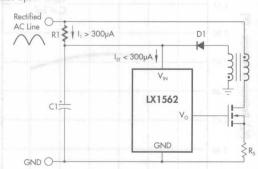


FIGURE 24 — TYPICAL APPLICATION OF START-UP CIRCUITRY

TABLE 1						
Part #	Start-Up Voltage	Hysteresis Voltage				
LX1562	13.1V	5.2V				
LX1563	9.8V	2.1V				



# SECOND-GENERATION POWER FACTOR CONTROLLER

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## IC DESCRIPTION

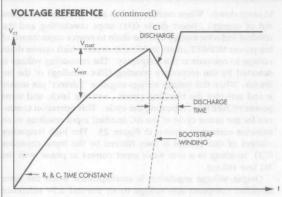


FIGURE 25 — START-UP CAPACITOR VOLTAGE

#### **VOLTAGE REFERENCE**

The voltage reference is a low drift bandgap design which provides a stable +2.5V output with maximum of  $\pm 1.5\%$  initial accuracy. This voltage is internally tied to the non-inverting input of the amplifier and is not available for external connection. The initial accuracy of the reference includes error amplifier input offset voltage. Figure 26 shows typical variation of the reference voltage vs. temperature.

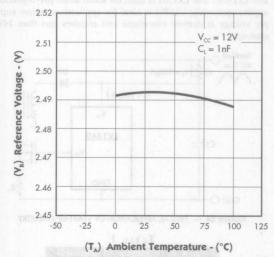


FIGURE 26 — REFERENCE VOLTAGE (Including Offset) vs. TEMPERATURE

## ERROR AMPLIFIER

The error amplifier is an internally compensated op-amp with access to the inverting input and the output pin. The noninverting input is internally connected to the voltage reference and is not available for external connection. The amplifier is designed for an open loop gain of 80dB, along with a typical bandwidth of 1.7MHz and 49 degrees of phase margin. The boost output voltage of the power factor pre-regulator is divided down and monitored by the inverting input. Input bias current (0.5µA max) can cause an output voltage error that is equal to the product of the input bias current and the value of the upper divider resistor. The amplifier's output is available for external loop compensation. Typically, the loop bandwidth is set below 10Hz in order to reject the low frequency ripple associated with 2X the line frequency. For example, if the error amplifier is configured as an integrator with 1.2Hz bandwidth, it will have 40dB ripple rejection at 120Hz frequency. This means that if the output of the error amp is allowed to have 100mV of ripple, the boost converter must be limited to less than 10V of ripple on its output.

To prevent boost output run away condition that may occur during removal of the output load, a separate comparator monitors the E.A. output voltage and compares it to an internal 1.8V reference. When load is removed, E.A. output swings lower than 1.8V, trips the comparator and turns output driver off till the inverting input voltage drops below 2.5V. At this point, the E.A. output swings positive, turns the output driver back on and repeats the cycle until the load is returned to normal condition.

To reduce output overshoot during line and load transients, the E.A. output is clamped to two diode drops above the reference voltage. This prohibits the amplifier from being saturated, allowing it to recover faster thus minimizing the boost voltage overshoot.

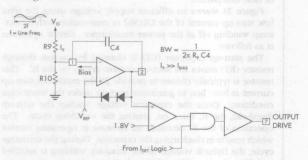


FIGURE 27 — THE AMPLIFIER CONFIGURED AS AN INTEGRATOR FOR LOOP COMPENSATION



## PRODUCTION DATA SHEET

#### IC DESCRIPTION

#### MULTIPLIER

The LX1562/63 features a one quadrant multiplier stage having two inputs. One  $(V_{M2})$  is internally driven by a DC voltage which is the difference of E.A. output and  $V_{REF}$ . The other  $(V_{M1})$ , is connected to an external resistor divider monitoring the rectified AC line. The output of the multiplier which is a function of both inputs, controls inductor peak current during each cycle of operation. This allows the inductor peak current to follow the AC line thus forcing the average input current to be sinusoidal.

The multiplier is in the linear region if the  $V_{\rm MI}$  input is limited to less than 2V and the E.A. output is kept below 3.5V under all line and load conditions. The output is internally clamped to 1.24V typically to limit the MOSFET peak current during turn on or under excessive load conditions. The equation below describes the relationship between multiplier output voltage and the its inputs.

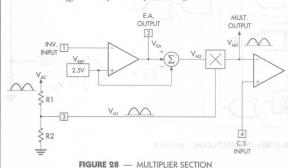
$$V_{M0} = K * V_{M1} * (V_{EA0} - V_{REF})$$

where: K = Multiplier gain (typ. 0.65)

 $V_{M1}$  = Voltage at pin3 (0 to 2V)

 $V_{EA0}^{MT}$  = Error amp output voltage (2.5 to 3.5V)

V<sub>M0</sub> = Multiplier output voltage



#### **CURRENT SENSE COMPARATOR**

Current sense comparator is configured as a PNP input differential stage with one input internally tied to the multiplier output and the other available for current sensing. Current is converted to voltage using an external sense resistor in series with the external power MOSFET. When sense voltage exceeds the threshold set by the multiplier output, the current sense comparator terminates the gate drive to the MOSFET and resets the PWM latch. The latch insures that the output remains in a low state after the switch current falls back to zero. The LX1562/63 features a leading edge blanking circuit that eliminates the need

for an external RC filter otherwise required for proper operation of the circuit. This function is described in detail under "current detect logic" section.

The current sense comparator voltage is limited by an internal 1.24V (typ.) voltage clamp of the multiplier output. Therefore maximum switch current is typically given by:

$$I_{PK (MAX)} = 1.24 V / R_{S}$$

Maximum switch peak current happens at full load and minimum line conditions.

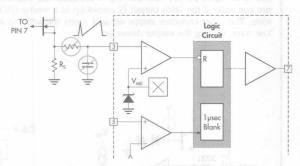


FIGURE 29 — CURRENT SENSE SECTION

#### CURRENT DETECT LOGIC

The function of "current detect logic" is to sense the operating state of the boost inductor and to enable the output driver accordingly. To achieve this, the downward slope of the inductor current is indirectly detected by monitoring the voltage across a separate winding and connecting it to the detector input " $I_{\rm DET}$ " pin. Once the inductor current reaches ground level, the voltage across the winding reverses polarity and changes the " $I_{\rm DET}$ " input and the comparator output to the low state (See Figure 30). When comparator changes state, it sets the latch and turns on the output driver for a period of 1µs (typ.) regardless of any changes in the latch output  $(\overline{\mathbb{Q}})$  within this period. This ensures that if the C.S. comparator changes state due to any turn-on spike, the driver output remains on and does not turn off prematurely.

However if the spike lasts longer than 1µs, the output driver turns off and the MOSFET stops conducting. This type of digital current sense blanking which is not amplitude dependent has higher noise immunity than the commonly used external RC filtering, allowing for more flexibility in board layout.

Since inductor voltage swings both positive and negative, internal voltage clamping is provided to protect the IC. The



# SECOND-GENERATION POWER FACTOR CONTROLLER

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#### IC DESCRIPTION

#### **CURRENT DETECT LOGIC** (continued)

upper 7.8V clamp prevents input overvoltage breakdown during switch off time, while during the on time the lower 0.7V clamp prevents substrate injection. An internal current limit resistor protects the lower clamp transistor in case the " $I_{\rm DET}$ " pin is accidently shorted to ground.

#### START-UP TIMER

A start-up timer circuit eliminates the need for an external oscillator when used in stand alone applications. The timer, as shown in Figure 30, provides a means to automatically start the pre converter if the latch output  $\overline{\mathbb{Q}}$  comes up in a wrong (HI) state. The timer capacitor ramps up and resets the latch to a low state, turning the output driver on.

#### **OUTPUT DRIVER STAGE**

The LX1562/63 output driver is designed for direct driving of an external power MOSFET. It is a totem pole stage with ±500mA peak current capability. This typically results in a 130ns rise and fall times into a 1000pF capacitive load. Additionally the output is held low during the undervoltage condition to ensure that the MOSFET remains in the off state until supply voltage reaches the start-up threshold.

Internal voltage clamping ensures that output driver is always lower than 13.8V (typ.) when supply voltage variation exceeds more than rated  $V_{\rm GS}$  threshold (typ 20V) of the external MOSFET. This eliminates an external zener diode and extra power dissipation associated with it that otherwise is required for reliable circuit operation.

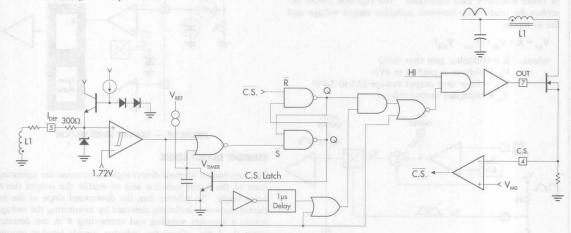


FIGURE 30 — START-UP TIMER & CURRENT DETECT LOGIC CIRCUITRY

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#### APPLICATION INFORMATION

#### TYPICAL APPLICATION

The application circuit shown in Figure 31 uses the LX1562 as the controller to implement a boost type power factor regulator. The I.C. controls the regulator, such that the inductor current is always operating in a discontinuous conduction mode with no current gaps. This mode of operation has several advantages over the fixed frequency discontinuous conduction mode: 1) The switching frequency adjusts itself to the AC line envelope, causing a sinusoidal current draw, 2) Since there is no current gap between the switching cycles, the inductor voltage does not oscillate, causing less radiated noise, 3) The lower peak inductor current causes less power dissipation in the power MOSFET.

A set of formulas have been derived specifically for this mode, and are used throughout the design procedure. An example with the following specifications for the boost converter is given as:

Input Voltage Range - 100 to 130V RMS

Output Power - 80W Efficiency - 95% at full load

Power Factor - > 0.99 at full load Total Harmonic Distortion - < 10% at full load

followed by a step by step design procedure which walks through component selection.

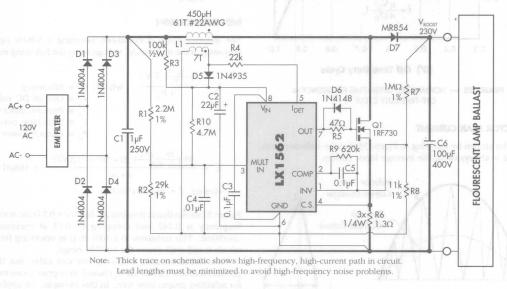


FIGURE 31 — TYPICAL APPLICATION OF THE LX1562 IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL

#### **OUTPUT VOLTAGE REQUIREMENT**

Since the converter is a boost type topology, it requires the output voltage to always be higher than the input voltage. It is recommended to select this voltage at least 15% higher than the maximum input voltage in order to: A) Avoid the inductor saturation during line transience, and B) To keep the operating frequency above the audible range at high line.

Figure 32 (next page) shows that when boost voltage is selected near the maximum AC line, the increase in off-time could reduce the operating frequency below the audible frequency and cause inductor humming. In fact, Figure 32 (next page) shows

that for  $\pm 13\%$  (100V to 130V) change in the line voltage the optimum range of the operating frequency is when off-time duty cycle (D') is between 0.57 and 0.75. This means that the boost voltage needs to be 245V when selecting D' = 0.75 at maximum AC line.

In this example, D' is chosen to be 0.8, to slightly reduce the voltage rating of the back end DC to AC fluorescent lamp inverter. This sets the boost voltage at:

$$V_{o} = \frac{130 * \sqrt{2}}{0.8} = 230V$$



# Second-Generation Power Factor Controller

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## APPLICATION INFORMATION

#### **OUTPUT VOLTAGE REQUIREMENT** (continued)

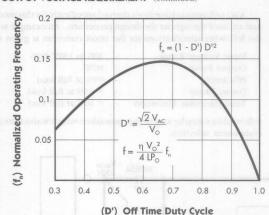


FIGURE 32 — NORMALIZED OPERATING FREQUENCY vs. OFF-TIME DUTY CYCLE

#### INDUCTOR PEAK CURRENT

It can be shown by referring to Figure 33 that the inductor peak current is always twice the average input current.

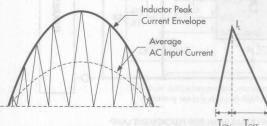


FIGURE 33 — INDUCTOR CURRENT

$$I_{IN(t)} = \sum AVE [I_L(t)]$$

$$I_{IN} = \frac{1}{T} \left[ \frac{(I_L)(T)}{2} \right] = \frac{I_L}{2}$$

I,p = Inductor peak current at peak input voltage

Maximum peak input current can be calculated using:

$$I_p = \frac{2P_O}{\eta V_p}$$

where:  $\eta \equiv Converter$  efficiency  $V_p \equiv Peak AC input voltage$ 

assuming: 
$$\eta = 95\%$$
,  $P_{O} = 80W$ ,  $V_{Pmin} = 100\sqrt{2} = 141$ 

$$I_p = \frac{2 \times 80}{(.95)(141)} = 1.2A$$

$$I_{LP/min AC} = 2 * 1.2 = 2.4A$$

#### INDUCTOR DESIGN

The inductor value is calculated assuming a 50KHz operating frequency at the nominal AC voltage using the following equation:

$$L_{1} = \frac{\eta \frac{V_{o} \cdot V_{p}}{V_{o}} T V_{p}^{2}}{4 P_{o}} \quad \text{where: } \eta \equiv \text{Efficiency}$$

$$V_{o} \equiv \text{Output DC voltage}$$

$$V_{p} \equiv \text{Peak AC input voltage}$$

$$T \equiv \text{Switching period}$$

$$P_{o} \equiv \text{Output Power}$$

$$L_1 = \frac{.95 \left(\frac{230 - 120\sqrt{2}}{230}\right) 20 * 10^{-6} * (120\sqrt{2})^2}{4 * 80} = 448\mu H$$

choose T = 20usec (50kHz)

Figure 32 shows that at nominal AC line (D' = 0.74) the normalized frequency is 0.142 and dropping to 0.13 at maximum line condition. This translates to a 10% drop in operating frequency which is still well above the audible range.

Once the inductance is known, we can either use the area product method (AP) or the K<sub>o</sub> (based on copper losses method), for selecting proper core size. In this example, we apply the K approach using the following steps:

# Step 1: Calculate Kg using

$$K_g = \frac{\Omega}{P_{CU}} (\frac{L_1 I_{LP}^2}{B})^2$$

where:  $L_1 \equiv \text{Required inductance}$   $\Omega \equiv 1.724 * 10^{-8} \, \text{m}$   $B \equiv \text{Maximum flux density}$   $I_{LP} \equiv \text{Maximum peak inductor current}$   $P_{CU} \equiv \text{Maximum copper dissipation}$ 

Assume: 
$$P_{CU} = 1.6W$$
 (2% of total output)  

$$K_g = \frac{1.724 * 10^8}{1.6} \left[ \frac{450 * 10^6 * (2.4)^2}{0.15} \right]^2 = 3.21 * 10^{.12} \text{ m}^5$$



# Second-Generation Power Factor Controller

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#### APPLICATION INFORMATION

### INDUCTOR DESIGN (continued)

Step 2: Choose a core with higher K than the one calculated in

$$K_g/\text{core} = k \frac{A_w A_E^2}{l_w}$$

where:  $k \equiv \text{Winding coefficient (typ. k=0.4)}$   $A_{\text{W}} \equiv \text{Bobbin window area}$   $A_{\text{E}} \equiv \text{Effective core area}$   $l_{\text{W}} \equiv \text{Mean length per turn}$ 

 $\begin{array}{c} \text{K}_{\text{g}} \text{ factor for TDK PQ2625}; \\ \text{A}_{\text{W}} = 47.7 \text{mm}^2 \\ \text{A}_{\text{E}} = 118 \text{mm}^2 \\ \text{l}_{\text{W}} = 56.2 \text{mm} \end{array}$ 

 $K_g = 0.4 \frac{(47.7) (118)^2}{56.2} (mm)^5 = 4.7 * 10^{-12} m^5$ 

Step 3: Determine number of turns.

$$N = \frac{L I_{LP}}{B A_{E}}$$

$$A_{\text{WIRE}} = k \frac{A_{\text{w}}}{N} = 0.4 \frac{47.7}{61} = 0.31 \text{mm}^2$$
  
= 480mil<sup>2</sup>

choose #22 AWG with  $r = 0.0165\Omega$ /feet resistance.

$$R_{\rm W} = N * l_{\rm w} * r$$

$$R_{\rm W} = 0.185\Omega$$

Step 4: Calculate air gap.

$$l_g = \frac{\mu_O N^2 A_E}{I}$$

$$l_{q} = \frac{4\pi * 10^{-7} * (61)^{2} * 118 * 10^{-6}}{450 * 10^{-6}} = 0.122cm = 48 \text{ mil}$$

#### **CURRENT SENSE RESISTOR**

Current sense resistor, R6 is selected using the minimum multiplier output clamp voltage and the maximum inductor peak

current such that:
$$R6 = \frac{V_{\text{CLAMP(MIN)}}}{I_{\text{L MAXO}}} = \frac{1.1}{2.4} = 0.45\Omega$$

Power dissipation is approximated by: 
$$P_{R} \approx \frac{1}{6} \ I_{2 \text{ MANO}}^2 (1 - D'_{\text{MIN}}), \quad \text{where } D'_{\text{MIN}} = 1 - \frac{\sqrt{2} \ V_{\text{ACOMINO}}}{V_{\text{BOOST}}}$$

$$P_{R} \approx \frac{1}{6} \ (2.4)^2 \ (1 - 0.61) = 0.374$$

Select **THREE** 1.3 $\Omega$ , <sup>1</sup>/<sub>4</sub>W carbon comp resistors in parallel.

#### MULTIPLIER COMPONENT SELECTION

Calculate R1 & R2 resistor values such that under low line AC input the multiplier output is lower than the minimum clamp voltage.

$$\frac{R2}{R1+R2}*\sqrt{2}\;V_{\text{AC (MIN)}}*K*(V_{\text{EAO (MAX)}}-V_{\text{REF}}) < V_{\text{CLAMP (MIN)}}$$

 $V_{EAX(MAX)} \equiv Maximum error amp output where$ multiplier is still in linear range. This voltage is  $\approx 3.5$ V.

For K = 0.65 &  $V_{CLAMP (MIN)}$  = 1.1V, the ratio of R1/R2 is:

Assuming R1 is selected to be:

$$R2 = \frac{2.2M}{83} = 26.4k (1\%)$$
 select  $R_2 = 26.7k (1\%)$ 

\* For high input applications such as 277V, R1 must be divided into two resistors in series to meet the maximum rated voltage of the resistors.

To improve THD further (typ. 2-3%), a high value resistor can be connected from the supply voltage to this pin to allow an increase in the switch on-time at the zero crossing by adding an effective offset at the multiplier output.

#### **ERROR AMPLIFIER COMPONENT SELECTION**

Boost voltage is programmed with R7 & R8 resistor dividers using the following equation:

$$\frac{R7}{R8} = \frac{V_{BOOST}}{V_{REF}} -1,$$

assuming that the product of R7 and the E.A. input bias current does not cause significant error in the output voltage setting.

Assuming  $R7 = 1M\Omega$  (for output voltage of higher than 250V, two resistors may be added in series to meet the voltage requirement of the resistor.)

$$\Delta V_{ERROR}$$
 (106) (0.5 \* 106) = 0.5V, which is < 0.25% of the output voltage.

Calculating R8:

$$R8 = \frac{R7}{\frac{V_{BOOST}}{V_{--}} - 1} = 11k \quad (1\%)$$

Worst case output tolerance is the total of ±3.75% which is the sum of ±1.5% (Ref), ±2% (resistor dividers), and ±0.25% (E.A. input bias current).

### SECOND-GENERATION POWER FACTOR CONTROLLER

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### APPLICATION INFORMATION

### ERROR AMPLIFIER COMPONENT SELECTION (continued)

Capacitor C5 is primarily selected to reject the output ripple associated with twice the line frequency. For a 40dB ripple

$$C5 \ge \frac{100}{2\pi \, f, R7}$$

C5 
$$\geq \frac{100}{2\pi f_1 R7}$$
 where  $f_1 = 2x$  line frequency

C5  $\geq \frac{100}{2\pi * 120 * 2.2 * 10^6} = 0.062 \mu F$ , Select **C5 = 0.1  $\mu F$** 

Resistor R9 can be used to improve load transient response at the cost of loosing 1 or 2% of load regulation. The value of this resistor should be much greater than R8:

$$R9 = 620k$$

One way of achieving desired load transient response without resorting to a complex mathematical model of the converter, is to dynamically switch the output load and empirically find the compensation network. The value of resistor R9 is selected using the method shown in Figure 34.

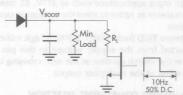


FIGURE 34 — LOAD TRANSIENT RESPONSE CIRCUIT

### I DETECT COMPONENT SELECTION

Figure 35 shows voltage envelope generated by flyback voltage across IDET winding:

Select turns ratio n such that,

$$n = \frac{5V}{V_{\text{BOOST}} - \sqrt{2} V_{\text{AC (MAX)}}}$$

$$n = \frac{5V}{230 - \sqrt{2} * 130} = 0.1$$

I<sub>DET</sub> winding turns are selected to be 7T.

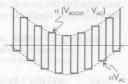


FIGURE 35 — FLYBACK VOLTAGE ACROSS IDET WINDING

and R4 resistor:

$$\frac{n * V_{BOOST}}{3 * 10^{-3}} < R4 < 500k$$

$$\frac{0.11 * 230}{3 * 10^{-3}}$$
 < R4 < 500k, or 8.4k < R4 < 500k

Select R4 = 22k

#### SUPPLY VOLTAGE

Resistor R3 must be selected such that it ensures converter startup at low line and is rated for high line power dissipation.

$$R3 < \frac{\sqrt{2} * 100}{0.3 * 10^{-3}} = 466 k\Omega$$

 $R3 > 4 V_{AC (MAX)}$  (to keep power dissipation below 0.5W)

$$R3 > 68k$$
, select  $R3 = 120k$ .

Start-up time of converter is given by:

$$T_{ST (MAX)} \approx C2 \frac{V_{ST}}{\sqrt{2} V_{AC (MIN)}} - I_{ST}$$

for our application this will be 25ms/µF

The start-up capacitor is selected such that capacitor discharge time is always longer than the time it takes for the bootstrap voltage to reach above the minimum start-up threshold of the IC.

C3 
$$< \frac{I_{OP} * \Delta t}{\Delta V_{MIN}}$$
 where:  $I_{OP} \equiv Maximum dynamic supply current of the IC  $\Delta t \equiv Rise time of the hootstray voltage$$ 

bootstrap voltage ΔV<sub>MIN</sub> ≡ Minimum hysteresis voltage (4V for 1562, 1.7V for 1563)

C3 
$$< \frac{10 * 10^3 * 10 * 10^3}{4} = 29 \mu F$$

Start-up time is approximately 0.8 seconds.

The auxiliary winding turns are selected such that it provides 15V

$$N_s \approx N_p * \frac{V_s}{V_o} = 61 * \frac{V_s}{V_o} = 4T$$

However, in this example  $I_{\text{DETECT}}$  winding is used to power the IC which eliminates the need for a third winding. This is possible since the internal clamping of the output drive limits the gate drive voltage to 14V (typ.) if the supply voltage exceeds this limit.



### Second-Generation Power Factor Controller

### PRODUCTION DATA SHEET

### APPLICATION INFORMATION

#### POWER MOSFET SELECTION

The voltage rating of MOSFET and rectifier must be higher than the maximum value of the output voltage.

$$V_{DS} \ge 1.2 V_{OMAX}$$
  $V_{DS} \ge 282V$ 

$$V_{DS} \ge 282V$$

The RMS current can be approximated by multiplying the RMS current at the peak of the line by 0.7.

$$I_{pMS} = 0.7 I_{1D} \sqrt{D/3}$$

$$I_{RMS} = 0.7 I_{IP} \sqrt{D/3}$$
 D = On-time duty cycle

D = 0.39 at 
$$V_{AC} = 100V$$
  
 $I_{LP} = 2.4A$ 

$$I_{LP} = 2.4A$$

$$I_{RMS} = (0.7)(2.4)(\sqrt{.39/3}) = 0.61A$$

$$R_{DS} \le \frac{P_{DC}}{I_{RMS}^2}$$

$$R_{DS} \le \frac{P_{DC}}{I_{PMS}^2}$$

$$P_{DC}$$
 = allowable power  $I_{RMS}$ /triangle =  $I_{LP}$   $\sqrt{D/3}$  dissipation.

$$R_{DS} \le \frac{1}{0.61} = 1.6\Omega$$

IRF730 with  $R_{DS} = 1\Omega$  and  $V_{DS} = 400V$  meets the above requirements.



The current through each diode is a half-wave rectified sine wave. The maximum current happens at minimum line with a peak

$$I_{AVE} = \frac{I_{PEAK}}{\pi} = \frac{1.2}{\pi} = 0.38A$$

choose 1N4004 with 1A rating.

$$P_{DISS} = (I_{AVE}) (V_F) = 0.38 \times 0.9 = 0.344W$$

$$T_{J} = T_{A} + P_{D} \times \theta_{J}$$

 $T_J = T_A + P_D \times \theta_{JA}$  assuming  $\theta_{JA} = 65$ °C/W for 1/8" lead length.

$$T_1 = 80 + (.344)(65) = 102^{\circ}C$$

Assuming  $\phi$  is the percentage of allowable input current ripple, C1 can be calculated using the following equations:

$$R_{EFF} = \frac{2 P_{\odot}}{\eta I_{P}^{2}}$$

$$C1 \ge \frac{1}{\varphi 2\pi R_{\text{eff}} f_{\text{SW}}}$$

 $C1 \ge \frac{1}{\phi \ 2\pi \ R_{\rm EFF} \ f_{\rm SW}} \qquad \qquad f_{\rm SW} \equiv \ {\rm Switching \ frequency}$  of inductor current at peak input voltage

if 
$$\omega = 30$$

if 
$$\varphi = 3\%$$

$$R_{EFF} = \frac{2 \times 80}{(.95)(1.2)^2} = 117\Omega$$

$$C1 \ge \frac{1}{(.03)(2\pi)(117)(50000)} = 0.9\mu F$$

choose 1µF, 250V capacitor.

#### **OUTPUT CAPACITOR SELECTION**

There are mainly two criteria for selecting the output capacitor: A large enough capacitance to maintain a low ripple voltage, and a low ESR value in order to prevent high power dissipation due to RMS currents.

The output capacitance can be approximated from the following equation:

$$C6 \ge \frac{I_{DC}}{2\pi f} \Delta V$$

 $C6 \ge \frac{I_{DC}}{2\pi f_{LINE} \Delta V} \qquad \text{where: } I_{DC} \equiv DC \text{ output current}$   $DV \equiv Output \text{ ripple}$  80 = 0.348A

$$I_{DC} = \frac{80}{230} = 0.348A$$

assuming 5% peak to peak ripple, \$200 DA

$$C6 \ge \frac{0.348}{2\pi (60) (11.5)} = 81\mu\text{F}$$

choose  $C6 = 100\mu F$ .

# LX1562/1563

### SECOND-GENERATION POWER FACTOR CONTROLLER

### PRODUCTION DATA SHEET

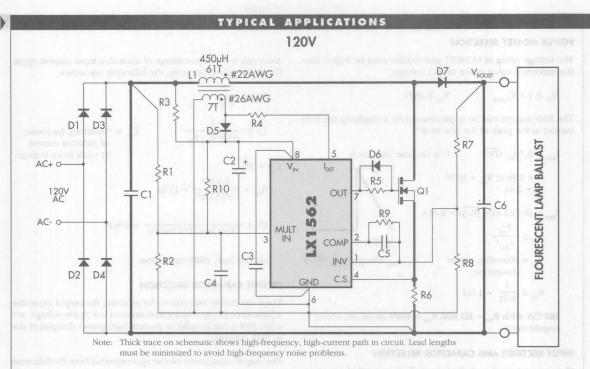


FIGURE 36 — TYPICAL APPLICATION OF THE LX1562 IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL.

Electrical Specifica- 120VAC Input — 230VDC / 80W Output					
Rei.	Component	Manuf.	Ref.	Component	Manuf.
IC L1 Q1 D1-D4 D5 D6 D7 R1 R2 R3 R4 R5 R6 R7 R8 R8 R8	LX1562 PQ2625/H7C1 Core IRF730, 400V, $1\Omega$ rds IN4004 1A, 400V 1N4935 1A 1N4148 (improves Q1 power dissipation) MR854, 3A, 400V 2.2 $M\Omega$ , $\pm 1\%$ 26.7 $K\Omega$ , $\pm 1\%$ 100 $K\Omega$ , $1/2$ VV 22 $K\Omega$ 47 $\Omega$ 1.5 $\Omega$ , Carbon type (3X) 1 $K\Omega$ , 1% 620 $K\Omega$ (improves load transient response) 4.7 $K\Omega$	Linfinity TDK I.R. Motorola Motorola Motorola Motorola	C1 C2 C3 C4 C5 C6	QXF2E105KRPT $1\mu$ F/250V - Plastic Film (high freq.) $22\mu$ F/35V - Electrolytic $0.1\mu$ F/50V - Ceramic $0.01\mu$ F/50V - Ceramic $0.1\mu$ F/50V - Ceramic $0.1\mu$ F/50V - Ceramic $0.1\mu$ F/50V - Ceramic $0.1\mu$ F/50V - Electrolytic $0.1\mu$ F/400V - Electrolytic $0.1\mu$ F/400V - Electrolytic $0.1\mu$ F/400V - Electrolytic $0.1\mu$ F/400V - Electrolytic	Nichicor



### SECOND-GENERATION POWER FACTOR CONTROLLER

PRODUCTION DATA SHEET

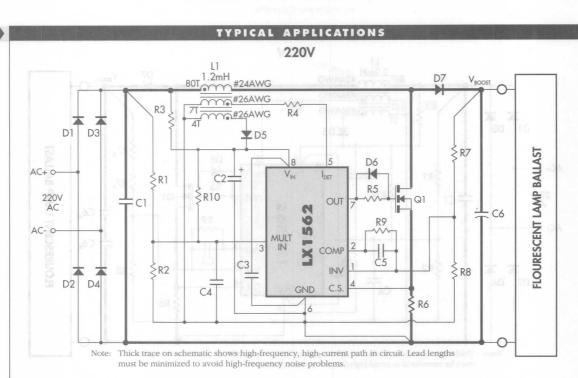


FIGURE 37 — TYPICAL APPLICATION OF THE LX1562 IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL.

Specifica- Specifica- 220VAC Input — 400VDC / 80W Output — 100 AVEVA   100 AVE					
Rei.	Component	Manuf.	Ref.	Component	Manuf.
IC L1 D1-D4 D5 D6 D7 D7 R1 R2 R3 R4 R5 R6 R7 R8 R9 R10	LX1562 PQ2625/H7C1 Core IRF830, 500V, 1.5 $\Omega$ rds IN4007 1A, 1000V 1N4935 1A 1N4148 (improves Q1 power dissipation) MR856, 3A, 600V 2.2M $\Omega$ , ±1% 12k $\Omega$ , ±1% 220k $\Omega$ , ½W 22k $\Omega$ 47 $\Omega$ 1.8 $\Omega$ , Carbon type (2X) 1M $\Omega$ , 1% 6.19k $\Omega$ , 1% 620k $\Omega$ (improves load transient response) 2.7M $\Omega$	I.R. Motorola Motorola	C1 C2 C3 C4 C5 C6*	QXF2J224KRPT 0.22μF/630V - Plastic Film 22μF/35V - Electrolytic 0.1μF/50V - Ceramic 0.01μF/50V - Ceramic 0.1μF/50V - Ceramic LGQ2W680MHS A/Z* 68μF/450V - Electrolytic  * A = 25mm diam. Z = 22mm diam.	NG-10 80 80



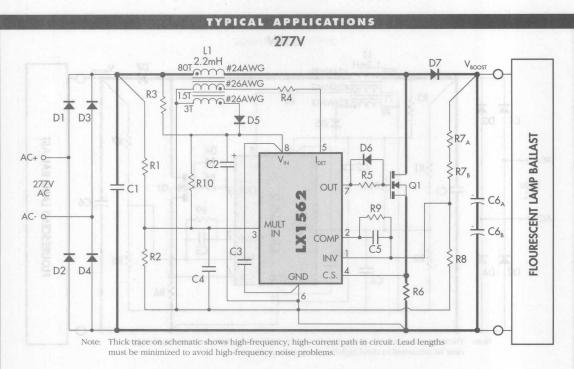


FIGURE 38 — TYPICAL APPLICATION OF THE LX1562 IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL.

Electrical Specifica- 277VAC Input — 480VDC / 80W Output					
Rer.	Component	Manuf.	Ref.	Component	Manuf.
IC L1 Q1 D1-D4 D5 D6 D7 R1 R2 R3 R4 R5 R6 R7 R8 R9 R10	LX1562 PQ2625/H7C1 Core IRF830, 500V, $1.5\Omega$ rds IN4007 1A, 1000V 1N4935 1A 1N4148 (improves Q1 power dissipation) MR856, 3A, 600V 2.2MΩ, ±1% 10kΩ, ±1% 390kΩ, $\frac{1}{2}$ W 22kΩ 47Ω 2.2Ω, Carbon type (2X) 499kΩ, 1% (2X) 5.23kΩ, 1% 620kΩ (improves load transient response) 2.2MΩ		C1 C2 C3 C4 C5 C6	GXF2J224KRPT 0.22μF/630V - Plastic Film 22μF/35V - Electrolytic 0.1μF/50V - Ceramic 0.01μF/50V - Ceramic 0.22μF/50V - Ceramic UVZ2F470MEH (2X) 47μF/315V - Electrolytic	Nichicor



### SECOND-GENERATION POWER FACTOR CONTROLLER

### PRODUCTION DATA SHEET

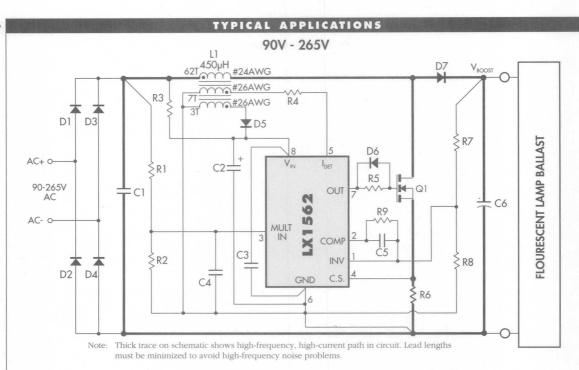


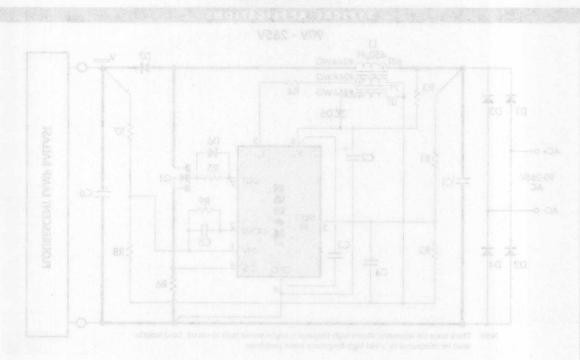
FIGURE 39 — TYPICAL APPLICATION OF THE LX1562 IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL.

Electrico Specific	90-265VAC Input — 400VDC / 80W Output						
Reï.	Component	Manuf.	Ref.	Component	Manuf.		
IC L1 Q1 D1-D4 D5 D6 D7 R1 R2 R3 R4 R5 R6 R6 R7 R8	LX1562 PQ2625/H7C1 Core IRF840, 500V, $1\Omega$ rds IN4007 1A, 1000V 1N4935 1A 1N4148 (improves Q1 power dissipation) MR856, 3A, 600V 2.2MΩ, ±1% 16.3kΩ, ±1% 130kΩ, ½W 22kΩ 47Ω 1Ω, Carbon type (4X) 1MΩ, 1% 6.19kΩ, 1% 620kΩ (improves load transient response)	Linfinity TDK I.R. Motorola Motorola Motorola	C1 C2 C3 C4 C5 C6*	QXF2J224KRPT 0.47µF/630V - Plastic Film 22µF/35V - Electrolytic 0.1µF/50V - Ceramic 0.01µF/50V - Ceramic 0.33µF/50V - Ceramic LGQ2W680MHS A/Z* 68µF/450V - Electrolytic  * A = 25mm diam. Z = 22mm diam.	Nichicon		



# Notes

#### PRODUCTION DATA SHEET



TORIOR SE — TVETCAL APPLICATION OF THE IX 265 FACTOR CONTROL

A concelere evaluation bount is available from Entirely Attended coronics Inc.



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# O LINFINITY

### LX1570/1571

PHASE MODULATED AC SYNCHRONOUS SECONDARY-SIDE CONTROLLER

THE INFINITE POWER OF INNOVATION

PRELIMINARY DATA SHEET

#### DESCRIPTION

The LX1570/71 series of controller ICs are designed to provide all control functions in a secondary-side regulator for isolated auxiliary or secondary power supplies. Auxiliary or secondary-side controllers are used in a variety of applications including multiple output off-line power supplies, commonly found in desktop computers, as well as telecommunications applications. Although they can be used in all secondary output applications requiring precision regulation, they are mainly optimized for outputs delivering more than 3A current where standard three-terminal regulators lack the desired efficiency. For these applications, the Mag Amp regulators have traditionally been used. However, Mag Amps have several disadvantages. First, because they have to withstand the maximum input voltage during a short-circuit condition, they are "over designed", typically by 2 times, increasing the cost and size of the power supply. Second, Mag Amps are inherently leading edge modulators, so they can only

approach a certain maximum duty cycle, limited by the minimum delay and the magnetic BH loop characteristic of the Mag Amp core. This forces an increase in the size of the main transformer as well as the output inductor, resulting in higher overall system cost. The LX1570/71 eliminates all the disadvantages of the Mag Amp approach as well as improving system performance and reducing overall system cost.

The LX1570/71 is a current mode controller IC that controls the duty cycle of a switch in series with the secondary AC output of the power transformer in buck-derived applications, such as forward or bridge topologies. It offers features such as 100% duty cycle operation for maximum energy transfer, pulse-by-pulse and hiccup current limiting with long off-time between the cycles for reduced power dissipation, high-frequency operation for smaller magnetics, softstart, and current mode control for excellent dynamic response.

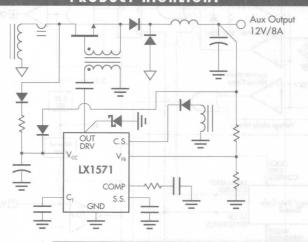
#### KEY FEATURES

- REPLACES COSTLY MAG-AMP CORES WITH A LOW ON-RESISTANCE MOSFET
- □ LOOK-AHEAD SWITCHING™ ENSURES SWITCH TURN ON BEFORE THE AC INPUT TO ACHIEVE 100% ENERGY TRANSFER
- □ LOWER OVERALL SYSTEM COST
- LOWER PEAK CURRENT STRESS ON THE PRIMARY SWITCH
- ALLOWS HIGHER OPERATING FREQUENCY AND SMALLER OUTPUT INDUCTOR
- EASY SHORT-CIRCUIT PROTECTION
- ☐ CURRENT MODE APPROACH ACHIEVES EXCELLENT DYNAMIC RESPONSE

#### APPLICATIONS

- SECONDARY-SIDE REGULATOR IN OFF-LINE POWER SUPPLIES
- COMPUTER POWER SUPPLIES, 3.3V OUTPUT FOR NEW LOW-VOLTAGE PROCESSORS AND MEMORIES
- TELECOMMUNICATION AND MILITARY DC/DC CONVERTERS

#### PRODUCT HIGHLIGHT



#### AVAILABLE OPTIONS PER PART #

Part #	C.L. Threshold	C.S. Option	Application
LX1570	-0.2V	Resistive Sensing	Output Currents < 4A
LX1571	1V	Current Transformer Sensing	Output Currents > 4A

### PACKAGE ORDER INFORMATION

T <sub>A</sub> (°C)	M Plastic DIP 8-pin	DM Plastic SOIC 8-pin	Y Ceramic DIP 8-pin
0 to 70	LX157xCM	LX157xCDM	_
-40 to 85	LX157xIM	LX157xIDM	_
-55 to 125	—ital		LX157xMY

Note: All surface-mount packages are available in Tape & Reel.

Append the letter "T" to part number. (i.e. LX157xCDMT)

#### FOR FURTHER INFORMATION CALL (714) 898-8121

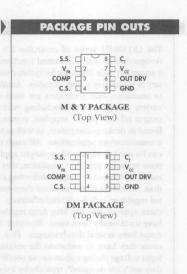
### LX1570/1571

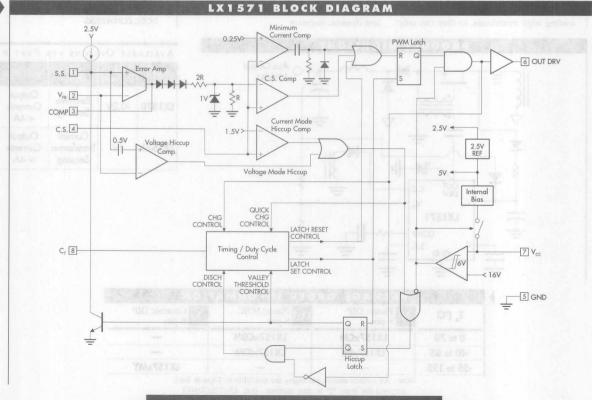
All of the above assume no ambient airflow.

### Phase Modulated AC Synchronous Secondary-Side Controller

### TARRES ATAG Y SA PRELIMINARY DATA SHEET

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### PHASE MODULATED AC SYNCHRONOUS SECONDARY-SIDE CONTROLLER

### PRELIMINARY DATA SHEET

### ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the ranges  $T_A = -55$  to 125°C for the LX1570M/1571M,  $T_A = -40$  to 85°C for the LX1570I/1571I, and  $T_A = 0$  to 70°C for LX1570C/1571C.  $V_{cc} = 15V$ . Typ. number represents  $T_A = 25$ °C value.)

Parameter		Symbol	Test Conditions	LX	1570/15	71	Units
Falailletei		Syllidoi	rest conditions	Min.	Тур.	Max.	OIIII
Reference Section							
Initial Accuracy		V <sub>RI</sub>	T <sub>A</sub> = 25°C, measured at F.B pin	2.475	2.500	2.525	V
Line Regulation		$\Delta V_{RL}$	11V < V <sub>cc</sub> < 25			±1	%
Temp Stability		$\Delta V_{RT}$	Note 2			±1.5	%
Timing Section	V	SE = VV	2.1 = .1.9 Amous = 1.5			QJ ti	Culton
Initial Accuracy		fo	$C_T = T_1 = 25$ °C, measured at pin 6	90	100	110	kH:
			Over Temp, measured at pin 6	85	100	115	kH:
Line Voltage Stability		$\Delta f_{OL}$		1.7	Stor	±1	%
Charging Current		I <sub>CHG</sub>			3	Internet '80	m/
Discharging Current		IDISCH	The state of the s		3.5	ESOR	m/
Leakage Current		ILK	C.S. <sub>INPUT</sub> = 1.5V	20	4	crests of	μА
Ramp PK to PK		V <sub>RPP</sub>	C.S. <sub>INPUT</sub> = OV	Bree	0.6		V
			C.S. <sub>INPUT</sub> = 1.5V (1571), C.S. <sub>INPUT</sub> = -0.4V (1570)		6		V
Error Amp / Soft Start Comp Sect	ion			-			
Transconductance	est control some significant	9 <sub>m</sub>	constitue de la constitue de l	Name and Address of the Owner, where the Owner, which is the Owner, whic	0.005	propertion to	μΩ
Input Bias Current		I <sub>B</sub>			0.1	1	LIA
Open Loop Gain		A <sub>VOL</sub>		60	70		dB
Output Sink Current	198 10 10 10 1 To	I <sub>EA(SINK)</sub>	V <sub>FR</sub> = 2.6V	200	400		μА
Output Source Current	s dWD of r	I <sub>EA(SOURCE)</sub>	$V_{\rm pg} = 2.4 \text{V}$ made to the special A long trute-flow Srift	200	400	1	μА
Output HI Voltage		V <sub>COMP-HI</sub>	note at may and T. our rune snepub these has fore	pro m so	5.1		٧
Output LO Voltage		V <sub>COMP-LO</sub>	ets the reference for the feedback regulator.	lop and s	etedu	0.8	V
Slew Rate		S			1		V/µS
Soft-Start Section	of balanen	or Allend	on at all transports actual advisor to the no	m is the m	d sin [	7	67
Soft Start Timing Factor	ORGEN HILL	K <sub>ss</sub>	mas sinder tassed are confeed or consent to	35	50	65	ms/L
Soft Start Discharge Current		I <sub>SS-DIS</sub>	TOTAL SEE TO THEIR SECURITY PORTO AND DESCRIP	OF SOME IN	TBD		mA
Current Sense Section		100.010				0 0	AFTT
Input Range	LX1570	V <sub>CSI</sub>	ARCHIOR SOURCE AFRICA ROBBIN SERICORD WITH	Line and the	EL SELL	-0.8	l v
	LX1571	CSI	Special Control State III	-0.3	130,000,000	6	V
Input Current	LX1570	I <sub>CSB</sub>	water of became a transport and mixed suit on branch	io vicini sur	Meson W.	25	μА
	LX1571	To Grant	seem incande concretto his ou. The o	an exchange	into acre	1	μА
C.S. Amplifier Gain	LX1570	A <sub>cs</sub>	internal gain (see option table) exceeds th	-13.5	-15	-16.5	VA
	LX1571	rol gyr V	e at this our during normal operation is 40-8	2.7	3	3.3	VA
Minimum Current Threshold Voltage	LX1570	V <sub>CSMIN</sub>			-50		m\
	LX1571	MARKET TOO	a lin. (Gito) mwoq bita gituono kinno bisii	in is cornt	250	2 1 0	m٧
C.S. Delay to Driver Output			10% Overdrive	. adq i	100	200	ns
C.L. Pulse-By-Pulse Threshold Voltage	LX1570	V <sub>CLP</sub>		-0.18	-0.2	-0.22	٧
nik dode such as LNSSIV agus b	LX1571	Weil most	t gue dive translature when develope	0.9	1	<u>1.1</u>	٧
C.L. Hiccup Threshold Voltage	LX1570	V <sub>CLH</sub>	the bit is take to take at the east	in all bala	-0.3		٧
	LX1571				1.5	_	٧
Voltage Hiccup Threshold	m Anuse he	V <sub>HCCP</sub>	The causes and the latering declars consider	369 St. III	2	1	٧

Note 2. Although this parameter is guaranteed, it is not 100% tested in production.



# LX1570/1571

### PHASE MODULATED AC SYNCHRONOUS SECONDARY-SIDE CONTROLLER

### PRELIMINARY DATA SHEET

Parameter	Symbol	Test Conditions	LX	1570/15	71	Units
Parameter	Symool	rest conditions	Min.	Тур.	Max.	Units
PWM Section						
E.A. Output to PWM Drive Offset	V <sub>OFS</sub>		1.7	2.0	2.4	٧
Fixed Duty Cycle	D		52	54	56	%
Output Drive Section	nig 8 3 3	V V = 95°C, measured a			Accuracy	felfini
Rise / Fall Time	t <sub>R</sub> / t <sub>F</sub>	C <sub>L</sub> = 1000pF		50	tobalues	ns
Output HI	V <sub>DH</sub>	$I_{SOURCE} = 200 \text{mA}, V_{CS} = 0 \text{V}, V_{FB} = 2.3 \text{V}$		13.5	Staulity	٧
Output LO	V <sub>DL</sub>	$I_{SINK} = 200 \text{mA}, V_{CS} = 1.2 \text{V}, V_{FB} = 2.3 \text{V}$		0.8	g Secti	V
Output Pull Down	V <sub>DPD</sub>	$V_{cc} = 0V$ , $I_{PULL UP} = 2mA$		1	Ассызы	e V
UVLO Section		Over Temp, measured				
Start-Up Threshold	V <sub>ST</sub>		15	16	17	V
Turn Off Threshold	V <sub>OFF</sub>		9	10	11	V
Hysterises	V <sub>H</sub>	1132	5.5	6	6.5	V
Supply Current Section		Vara <sub>ma</sub> 20 ml		i i	ge Currer	alas.i
Dynamic Operating Current	I <sub>Qd</sub>	Out Freq = 100kHz, C <sub>L</sub> = 0		18	30	mA
Start-Up Current	l <sub>st</sub>	((1) 41) YC 1 = 228 3 2		150	250	UА

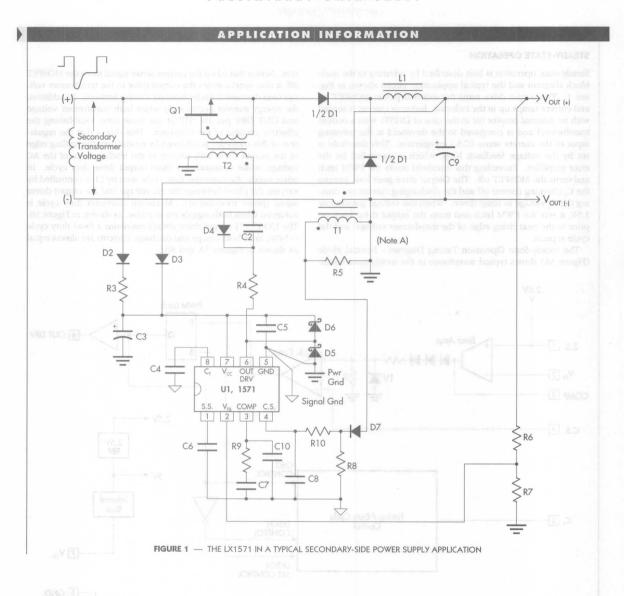
		FUNCTIONAL PIN DESCRIPTION
Pin	#	Description
S.S.	1	This pin acts as the soft-start pin. A capacitor connected from this pin to GND allows slow ramp up of the NI input resulting in output soft start during start up. This pin is clamped to the internal voltage reference during the normal operation and sets the reference for the feedback regulator.
V <sub>FB</sub>	2	This pin is the inverting input of the Error Amplifier. It is normally connected to the switching power supply output through a resistor divider to program the power supply voltage. This pin instead of the NI pin is internally trimed to 1% tolerance to include the offset voltage error of the error amp.
COMP	3	This pin is the Error Amplifier output and is made available for loop compensation. Typically a series R&C network is connected from this pin to GND.
AC.S.	4	A voltage proportional to the inductor current is sensed by an external sense resistor (1570) or current transformer (1571) in series with the return line and is connected to this pin. The output drive is terminated and latched off when this voltage amplified by the internal gain (see option table) exceeds the voltage set by the E.A output voltage. The maximum allowable voltage at this pin during normal operation is -0.8V typ for LX1570 and 6V typ for LX1571.
GND	5	This pin is combined control circuitry and power GND. All other pins must be positive with respect to this pin, except for C.S pin.
OUT DRV	6	This pin drives a gate drive transformer which drives the power mosfet. A Schottky diode such as 1N5817 must be connected from this pin to GND in order to prevent the substrate diode conduction.
V <sub>cc</sub>	7	This pin is the positive supply voltage for the control IC. A high frequency capacitor must be closely placed and connected from this pin to GND to provide the turn-on and turn-off peak currents required for fast switching of the power Mosfet.
C <sub>T</sub>	8	The free running oscillator frequency is programmed by connecting a capacitor from this pin to GND.



# LX1570/1571

### PHASE MODULATED AC SYNCHRONOUS SECONDARY-SIDE CONTROLLER

### PRELIMINARY DATA SHEET





#### IC DESCRIPTION

#### STEADY-STATE OPERATION

Steady-state operation is best described by referring to the main block diagram and the typical application circuit shown in Figure 1. The output drive turns the external power MOSFET on and current ramps up in the inductor. Inductor current is sensed with an external resistor (or in the case of LX1571 with a current transformer) and is compared to the threshold at the inverting input of the current sense (C.S.) comparator. This threshold is set by the voltage feedback loop, which is controlled by the error amplifier. Exceeding this threshold resets the PWM latch and turns the MOSFET off. The Output drive goes low, turning the  $\mathrm{C_r}$  charging current off and the discharging current on, causing the  $\mathrm{C_r}$  voltage to ramp down. When this voltage goes below 1.5V, it sets the PWM latch and turns the output drive back on prior to the next rising edge of the transformer voltage, and the cycle repeats.

The Steady-State Operation Timing Diagram - Normal Mode (Figure 3A) shows typical waveforms in the steady-state condi-

tion. Notice that when the current sense signal turns the MOSFET off, it also synchronizes the output drive to the transformer voltage (see discussion under heading Timing Section). In addition, the energy transfer occurs only when both transformer voltage and OUT DRV pin are "HI" at the same time, establishing the effective on-time of the converter. This shows that the regulation of this converter is achieved by modulating the trailing edge of the output drive with respect to the leading edge of the AC voltage, while maintaining a fixed output drive duty cycle. In other words, the converter duty cycle seen by L1 is controlled by varying the phase between the AC voltage and the output driver signal (phase modulation). Maximum converter duty cycle is achieved when both signals are in phase, as shown in Figure 3B. The LX1570/71 output drive always maintains a fixed duty cycle (≈54%), since both charge and discharge currents are almost equal as shown in Figures 3A and 3B.

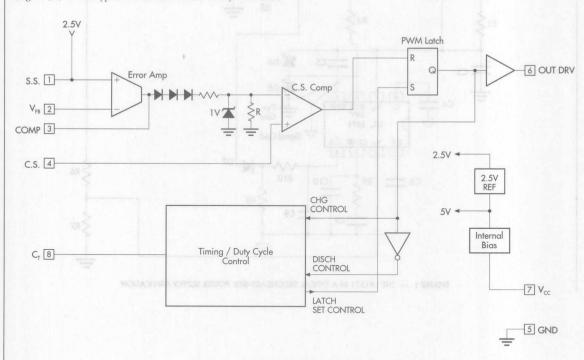
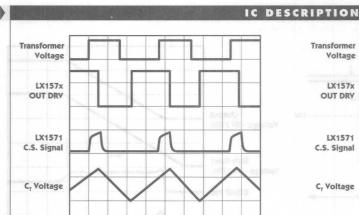


FIGURE 2 — STEADY-STATE OPERATION BLOCK DIAGRAM



### Phase Modulated AC Synchronous Secondary-Side Controller

### PRELIMINARY DATA SHEET



2µs / Div.

FIGURE 3A — STEADY-STATE OPERATION TIMING DIAGRAM (NORMAL MODE)

#### START-UP OPERATION

Using the main Block Diagram and the LX157x V<sub>cc</sub> Start-Up Voltage Timing Diagram (Figure 4) as a reference, when the V<sub>cc</sub> voltage passes the UVLO threshold (16V typ.), the output of the UVLO comparator changes to the "HI" state, which causes the following: a) provides biasing for internal circuitry, and b) enables the output drive and the HICCUP latch. This signal sets the "Q" output of the HICCUP latch "LO", allowing the soft-start (S.S.) capacitor voltage to ramp up, forcing the regulator output to follow this voltage. Since the IC provides a constant current source for charging the S.S. capacitor, the resulting waveform is a smooth linear ramp, which provides lower in-rush current

The Start-Up Timing Diagram (Figure 5) shows the output voltage and the S.S. capacitor during start up. Notice that the output voltage does not respond to the S.S. capacitor until this voltage goes above ≈0.65 volts, allowing this pin to be used as an external shutdown pin. The value of the soft start capacitor must be selected such that its ramp up time  $(t_{pamp})$  is always greater than the start up time of the converter, so that the converter is able to follow the soft-start capacitor.

It is recommended that the soft start capacitor is always selected such that its ramp up time (t<sub>RAMP</sub>) be at least 4 times greater than the converter's minimum start-up time. Equations 1 and 2 show how to select this capacitor.

$$t_{RAMP} = 4 * \frac{C_o * V_o}{I_o}$$
 Equation 1

Once  $t_{RAMP}$  is known, the soft-start capacitor can then be calculated as follows:  $C_{SS} = \frac{t_{RAMP}}{35}$  Equation 2

$$C_{ss} = \frac{t_{RAMP}}{35}$$
 Equation 2

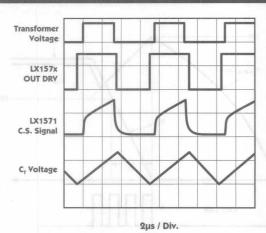


FIGURE 3B — STEADY-STATE OPERATION TIMING DIAGRAM (MAXIMUM DUTY CYCLE)

where  $C_{SS}$  is in  $\mu F$  and  $t_{RAMP}$  is in ms.

Example: If 
$$C_0 = 1600 \mu F$$
,  $V_0 = 12 V$ ,  $I_0 = 4 A$ 

$$t_{RAMP} = 4 * \frac{1600 * 10^{-6} * 12}{4} = 19.2 ms$$

$$C_{SS} = \frac{19.2}{35} = 0.55 \mu F$$

The LX1570/71 series also features micropower start-up current that allows these controllers to be powered off the transformer voltage via a low-power resistor and a start-up capacitor. After the IC starts operating, the output of the converter can be used to power the IC. In applications where the output is less than the minimum operating voltage of the IC, an extra winding on the inductor can be used to perform the same function. The start-up capacitor must also be selected so that it can supply the power to the IC long enough for the output of the converter to ramp up beyond the start-up threshold of the IC. Equation 3 shows how to select the start-up capacitor.

$$C_{ST} = 2 \left( \frac{I_Q * t_{ST}}{V_H} \right)$$
 Equation 3

where:  $I_Q$   $\equiv$  Dynamic operating current of the IC  $t_{ST}$   $\equiv$  Time for the bootstrap voltage to go above the minimum operating voltage (10V typ.)  $V_{HYST} \equiv Minimum hysteresis voltage of the IC$ 

Example: If 
$$I_Q = 30 \text{mA}$$
,  $t_{ST} = 19 \text{ms}$ ,  $V_{HYST} = 5.5 \text{V}$ 

$$C_{ST} = 2 \left( \frac{30 * 10^{-3} * 19 * 10^{-3}}{5.5} \right) = 207 \mu \text{F}$$

### LX1570/1571

### PHASE MODULATED AC SYNCHRONOUS SECONDARY-SIDE CONTROLLER

### PRELIMINARY DATA SHEET

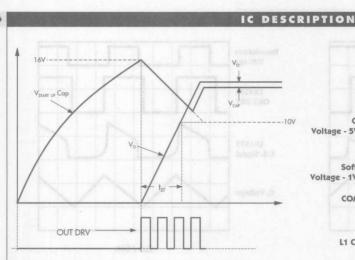
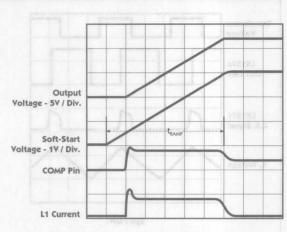


FIGURE 4 — LX157x V<sub>cc</sub> START-UP VOLTAGE TIMING DIAGRAM



1ms / Div.

FIGURE 5 — START-UP TIMING DIAGRAM

#### TIMING SECTION

A capacitor connected from the  $\mathrm{C_T}$  pin to ground performs several functions. First, it sets the OUT DRV duty cycle to a constant 54% (regardless of the  $\mathrm{C_T}$  value) in order to: a) provide the gate drive for an N-channel MOSFET, utilizing a simple gate drive transformer, and b) insure reliable operation with a transformer duty cycle within a 0 to 50% range. Second, it sets the freerunning frequency of the converter in order to insure the continuous operation during non-steady state conditions, such as start up, load transient and current limiting operations. The value of the timing capacitor is selected so that the free-running frequency is always 20% below the minimum operating frequency of the secondary transformer voltage, insuring proper operation. Equation 4 shows how to select the timing capacitor  $\mathrm{C_T}$ .

$$C_{T} = \frac{1}{V_{\text{RPP}} * f_{\text{S}} * \left[ \frac{1}{I_{\text{CHG}}} + \frac{1}{I_{\text{DISCH}}} \right]} \qquad \text{Equation 4}$$

 $\begin{array}{ccc} \text{where:} & V_{\text{\tiny RPP}} & \equiv & \text{Peak to peak voltage of } C_{\text{\tiny T}} \, (0.6 \text{V typ.}) \\ & \equiv & \text{Free-running frequency of the converter.} \\ & & \text{Selected to be 80\% of the minimum freq.} \\ & & \text{of the seconday side transformer voltage.} \end{array}$ 

 $I_{CHG} \equiv C_T$  charging current (3mA typ.)  $I_{DISCH} \equiv C_T$  discharge current (3.5mA typ.) Example: Assuming the transformer frequency is at 100kHz,  $V_{\text{RPP}} = 0.6V$ ,  $I_{\text{CHG}} = 3\text{mA}$ ,  $I_{\text{DISCH}} = 3.5\text{mA}$ .

$$C_{\rm T} = \frac{1}{0.6*80*10^3*\left[\frac{1}{3*10^{-3}} + \frac{1}{35*10^{-3}}\right]} = 0.033\mu$$

#### **CURRENT LIMITING**

Using the main Block Diagram as a reference and the typical application circuit of Figure 1, note that current limiting is performed by sensing the current in the return line using a current transformer in series with the switch. The voltage at C.S. pin is then amplified and compared with an internal threshold. Exceeding this threshold turns the output drive off and latches it off until the set input of the PWM latch goes high again. However, if the current keeps rising such that it exceeds the HICCUP comparator threshold, or if the output of the converter drops by ≈20% from its regulated point, two things will happen. First, the HICCUP comparator pulls C<sub>r</sub> pin to 6V, which keeps the output drive off and causes C<sub>x</sub> charging current to be disconnected. Second, it sets the HICCUP latch, causing the discharge current to be turned off until the C<sub>r</sub> capacitor voltage goes below 0.3V. Since both charge and discharge currents are disconnected from the capacitor, the only discharge path for C, is the internal 2µA current source. When this happens, a very slow discharge occurs, resulting in a long delay time between current limit cycles which greatly reduces power MOSFET dissipation under short circuit conditions.



### PHASE MODULATED AC SYNCHRONOUS SECONDARY-SIDE CONTROLLER

### PRELIMINARY DATA SHEET

### IC DESCRIPTION

#### MINIMUM CURRENT COMPARATOR

One of the main advantages of replacing a Magnetic Amplifier with a MOSFET, is the MOSFET's ability to respond quickly to large changes in load requirements. Because the LX1570/71 relies on the C.S. signal for synchronization, special circuitry had to be added to keep the output drive synchronized to the transformer voltage during such load transient conditions. This condition is best explained by referring to Figure 6. In Figure 6, it can be seen that the load current is stepped from 0.4A to 4A, causing the COMP pin to slew faster than the inductor current, starting with the second switching cycle after the load transient has occured. This condition eliminates the normal means of resetting the PWM latch through the C.S. comparator path. To compensate for this condition, a second comparator is ORed with the C.S. comparator, which resets the latch on the falling edge of the C.S. signal caused by the falling edge of the transformer voltage.

In other words, the function of the minimum C.S. comparator is to turn OUT DRV off on the falling edge of the C.S. signal, if it is not already off. This assures that the output drive is on before the start of the next AC input cycle (Look-Ahead Switching™), allowing maximum converter duty cycle.

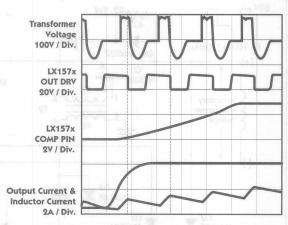


FIGURE 6 — MINIMUM CURRENT COMPARATOR EFFECT DURING LOAD TRANSIENT

#### ERROR AMPLIFIER

The function of the error amplifier is to set a threshold voltage for inductor peak current and to control the converter duty cycle, such that power supply output voltage is closely regulated. Regulation is done by sensing the output voltage and comparing it to the internal 2.5V reference. A compensation network based on the application is placed from the output of the amplifier to GND for closed loop stability purposes as well as providing high DC gain for tight regulation. The function of "3V  $_{\rm BE}$ " offset is to keep output drive off without requiring the error amplifier output to swing to ground level. The transfer function between error amp output (V  $_{\rm COMP}$ ) and peak inductor current is therefore given by:

$$V_{COMP} - 3V_{BE} = I_{P} * G$$

where:

I<sub>p</sub> = inductor peak current,

G = resistor divider gain,

(-15 for LX1570, 3 for LX1571)

 $V_{BE}$  = diode forward voltage (0.65V typ)

### PRELIMINARY DATA SHEET

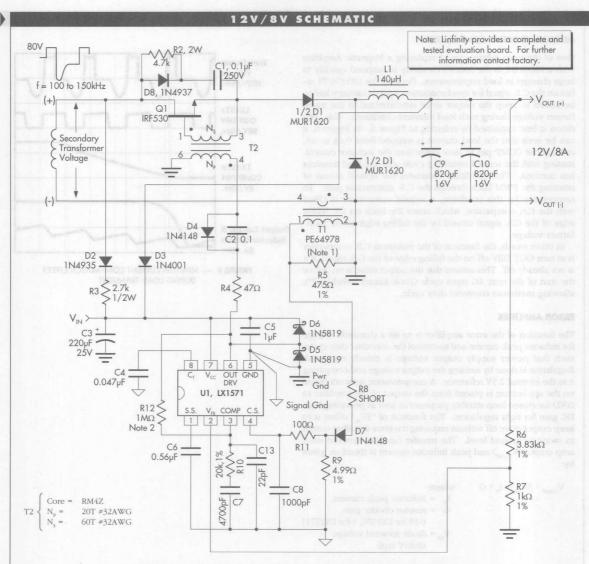


FIGURE 7 — THE LX1571 IN A 12V/8A SECONDARY-SIDE POWER SUPPLY APPLICATION

Unless otherwise noted all resistors are 1/4W, 5%.

Note 1: For further information on PE64978 contact Pulse Engineering at 619-674-8100.

Note 2: A high value resistor must be coupled back to "COMP" pin to insure proper operation under light load conditions.



# LX1570/1571

### PHASE MODULATED AC SYNCHRONOUS SECONDARY-SIDE CONTROLLER

### PRELIMINARY DATA SHEET

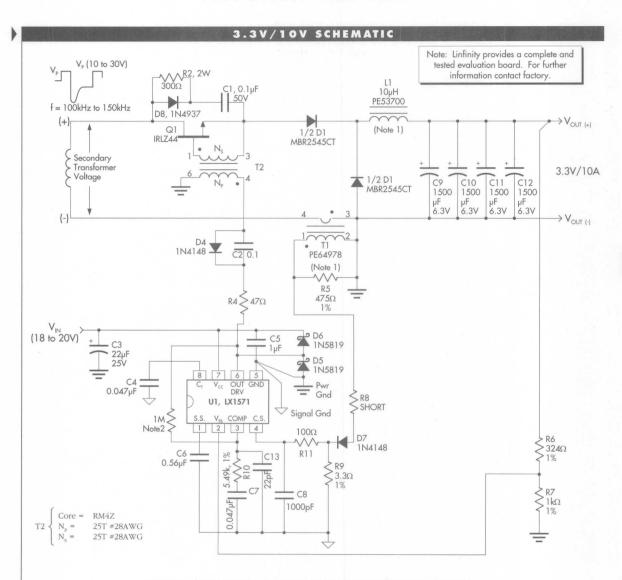


FIGURE 7 — THE LX1571 IN A 3.3V/10A SECONDARY-SIDE POWER SUPPLY APPLICATION

Unless otherwise noted all resistors are 1/4W, 5%.

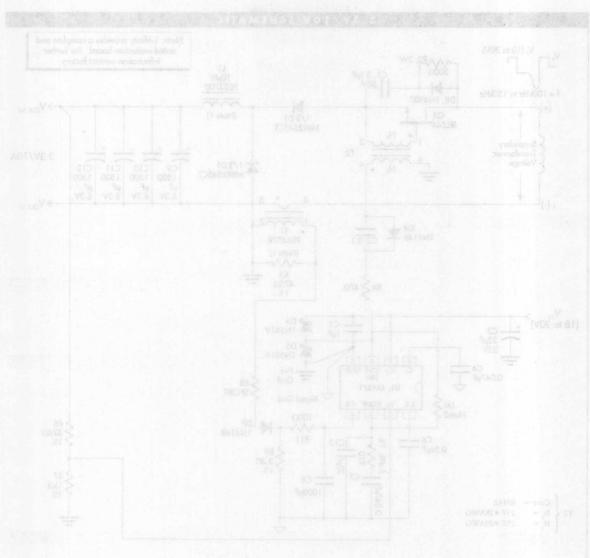
Note 1: For further information on PE53700 and PE64978 contact Pulse Engineering at 619-674-8100.

Note 2: A high value resistor must be coupled back to "COMP" pin to insure proper operation under light load conditions.



# Notes

#### TIERS ATAB YEARINISSE



NOTACIONAS ANTRE PROPERTIES DE CONSAGNA SIDE POWER SUPPLY APPLICATION

inless of servise noted all residues are 1.4%, 5%, 5%, contact Polse Engineering at a 1% of 1-4100.

Total 1: For further information on PESSTO and Polse Security Polse Engineering at a 1% of 1-4100.

The books of session must be equaled book to 200MP may be made up as expension under both load conditions.







THE INFINITE POWER OF INNOVATION

NOT RECOMMENDED FOR NEW DESIGNS

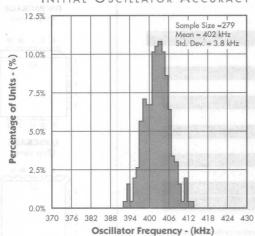
#### DESCRIPTION

The LX1823 is a high-performance pulse width modulator optimized for high frequency current-mode power supplies. Included in the controller are a precision voltage reference, micropower start-up circuitry, soft-start, high-frequency oscillator, wideband error amplifier, fast current-limit comparator, full double-pulse suppression logic, and a single totem-pole output driver. Innovative circuit design and an advanced linear Schottky process result in very short propagation delays through the current

limit comparator, logic, and the output driver. This device can be used to implement either current-mode or voltage-mode switching power supplies. The LX1823 is an ideal choice for applications such as single ended boost converters. The LX1823C is selected for the commercial range of 0°C to 70°C, the LX1823I is characterized for the industrial range of -25°C to 85°C, and the LX1823M is specified for operation over the full military ambient temperature range of -55°C to 125°C.

#### PRODUCT HIGHLIGHT

### INITIAL OSCILLATOR ACCURACY



#### KEY FEATURES

- IMPROVED OSCILLATOR INITIAL ACCURACY(±2% typ.)
- IMPROVED STARTUP CURRENT (460µA typ.)
- PROP DELAY TO OUTPUTS (80ns max.)
- 10V TO 30V OPERATION
- 5.1V REFERENCE TRIMMED TO ±1%
- 1.5MHz OSCILLATOR CAPABILITY
- 1.5A PEAK TOTEM-POLE DRIVERS
- U.V. LOCKOUT WITH HYSTERESIS
- NO OUTPUT DRIVER "FLOAT"
- PROGRAMMABLE SOFT START
- DOUBLE-PULSE SUPPRESSION LOGIC
- WIDEBAND LOW-IMPEDANCE ERROR AMPLIFIER
- CURRENT-MODE OR VOLTAGE-MODE CONTROL
- WIDE CHOICE OF PACKAGES

#### APPLICATIONS

- HIGH FREQUENCY DC/DC BUCK, BOOST, & FORWARD CONVERTERS
- SERVO MOTOR CONTROL

#### HI-REL FEATURES

- AVAILABLE TO MIL-STD-883B
- Linfinity LEVEL "S" PROCESSING AVALABLE

	PACKAGE ORDER INFORMATION						
T, (°C)	N Plastic DIP 16-pin	DW Plastic Wide SOIC 16-pin	Q Plastic LCC 20-pin	J Ceramic DIP 16-pin	L Ceramic LCC 20-pin		
0 to 70	LX1823CN	LX1823CDW	LX1823CQ	_	_		
-25 to 85	LX1823IN	LX1823IDW	LX1823IQ	LX1823IJ	_		
-55 to 125	- 1	_	-	LX1823MJ	LX1823ML		

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX1823CDWT)

### anasas walk sos as Not Recommended for New Designs

### ABSOLUTE MAXIMUM RATINGS (Note 1) Input Voltage (V<sub>IN</sub> and V<sub>C</sub>) ..... Analog Inputs: Error Amplifier and Ramp ......-0.3V to 7.0V Softstart and I<sub>m</sub>/S.D. -0.3V to 6.0V Driver Outputs .......-0.3V to V<sub>c</sub>+1.5V Source / Sink Output Current (each output): Continuous 0.5A Softstart Sink Current 20mA Operating Junction Temperature: Hermetic (J, L Package) Storage Temperature Range .....-65°C to 150°C Lead Temperature (soldering, 10 seconds) 300°C

#### Note 1. Exceeding these ratings could cause damage to the device.

### THERMAL DATA

N PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{\mathrm{JA}}}$	65°C/W
DW PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	95°C/W
Q PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{\mathrm{JA}}}$	80°C/W
J PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{\mathrm{JA}}}$	80°C/W
L PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO CASE, $\theta_{\rm JC}$	35°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}^{^{0}}$	120°C/W

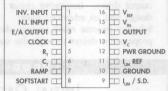
Junction Temperature Calculation:  $T_1 = T_2 + (P_2 \times \theta_1)$ .

The  $\theta_{1A}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow

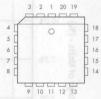
### PACKAGE PIN OUTS



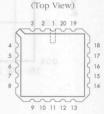
#### J & N PACKAGE (Top View)



#### DW PACKAGE (Top View)



### **Q PACKAGE**



#### L PACKAGE (Top View).

ì	1. N.C.	
ı	2. INV. INPUT	
1	3. N.I. INPUT	
	4. E/A OUTPUT	
1	5. CLOCK	
ı	6. N.C.	
	7. R <sub>T</sub>	
	8. C,	
1	9. RAMP	
1	10. SOFTSTART	

11. N.C. 12. I<sub>UM</sub> / S.D. 13. GROUND 14. I<sub>LM</sub> REF 15. PWR GND 16. N.C. 17. V. 18. OUTPUT 20. V

### NOT RECOMMENDED FOR NEW DESIGNS

			Conditions				
Parameter		Symbol	Min.	Тур.	Max.	Units	
Supply Voltage Range		V <sub>IN</sub> , V <sub>C</sub>	10	(Y SIDE) F	30	V	
Voltage Amp Common Mode Range	ye.	- WINDAS,	1.5		5.5	٧	
Ramp Input Voltage Range		VER + N	0		5.0	٧	
Current Limit / Shutdown Voltage Range		A178 + 11	0		4.0	٧	
Source / Sink Output Current		AF 01 1 = 10	FIUS AVI. 1 JOAN		Loco Galu	10 DQ	
Continuous	VCS = INTINO AS	d Vollage Pange	RR 19/0	200	reduction visory	mA	
Pulse, 500ns	10.2 = 70	STUD AS YOU O	1 x01 = "A.	1.5	Notice to A Address	A	
Voltage Reference Output Current		V1 4 71	RELIGIAN		10	mA	
Oscillator Frequency Range		V&= 71	4		1500	kHz	
Oscillator Charging Current		A360-41,	0.030	4-1-4-	3	mA	
Oscillator Timing Resistor		R <sub>T</sub>	1	44	100	kΩ	
Oscillator Timing Capacitor		C <sub>T</sub>	0.470	(4-8)	10	nF	
Operating Ambient Temperature Range:					(It show)	OF WAR	
LX1823C		TA	0	A district to B.	70	°C	
LX1823I		TA	-25		85	°C	
LX1823M		TAYF = T	-55		125	°C	

### ELECTRICAL CHARACTERISTICS (Note 3)

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for LX1823C with 0°C  $\leq$  T<sub>A</sub>  $\leq$  70°C, LX1823I with -25°C  $\leq$  T<sub>A</sub>  $\leq$  85°C, LX1823M with -55°C  $\leq$  T<sub>A</sub>  $\leq$  125°C, and V<sub>IN</sub>=V<sub>C</sub>=15V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX1823	C/1823I	/1823M	Units	
raidilletei	Jymoor	rest conditions	Min. Typ. A		Max.	Max.	
Reference Section							
Output Voltage	V <sub>REF</sub>	T <sub>J</sub> = 25°C, I <sub>L</sub> = 1mA	5.05	5.10	5.15	V	
Line Regulation		V <sub>IN</sub> = 10 to 30V		0.2	5	mV	
Load Regulation		I <sub>L</sub> = 1 to 10mA	ange	3	15	mV	
emperature Stability (Note 4) Over Operating Temperature			blorle	0.4	mV/°C		
Total Output Range (Note 4) Over Line, Load, and Temperature		Over Line, Load, and Temperature	5.00	Dalput	5.20	V	
Output Noise Voltage (Note 4) f = 10Hz to 10kHz		Blues no	50	WhO ha	µV <sub>RMS</sub>		
Long Term Stability (Notes 4 & 5) $T_1 = 125$ °C, $t = 1000$ hrs			5	25	mV		
Short Circuit Current		V <sub>REF</sub> = OV	-15	-50	-100	mA	
Oscillator Section (Note 6)		Amor = amor		lav	o Jaylera	Quip	
Initial Accuracy 0.81 0.91		$T_{\rm J} = 25$ °C, $C_{\rm CLOCK} \le 10$ pF	370	400	430	kHz	
Voltage Stability		V <sub>IN</sub> = 10 to 30V		0.4	2	%	
Temperature Stability (Note 4)		Over Rated Operating Temperature	(A STOLE	5	8	%	
Total Frequency Limits (Note 4)		Over Line and Temperature	350	ndods	450	kHz	
Minimum Frequency (1988)		$R_T = 100K\Omega$ , $C_T = 0.01\mu F$		session	4	kHz	
Maximum Frequency		$R_T = 1K\Omega$ , $C_T = 470pF$	1.5	F125783	eH tunda	MHz	
Clock High Level		$I_{CLK} = -1 \text{mA}$	3.9	4.3	terror of	V	
Clock Low Level		$I_{CLK} = -1 \text{mA}$		2.3	2.9	V	
Ramp Peak Voltage	V.	THERE I WAS A CASE IN SECRET THREE YEAR		2.7	and make	V	
Ramp Valley Voltage				1.0	1	٧	
Valley-to-Peak Amplitude		- Cult 1 = 20	9 4000	1.7	7 1	٧	

Note 3. Low duty cycle pulse testing techniques are used which maintains junction and case temperature equal to the ambient temperature.

Note 4. This parameter is guaranteed by design and process control, but is not 100% tested in production.

Note 5. This parameter is non-accumulative, and represents the random fluctuation of the reference voltage within some error band when observed over any 1000 hour period of time.



Note 2. Range over which the device is functional.

### NOT RECOMMENDED FOR NEW DESIGNS

ALESSA DE MANDE DE LA COMPANION DE LA COMPANIO		- 10 55	LX1823	3C/1823I	/1823M	Unit
Parameter	Symbol	Test Conditions	THE R. LEWIS CO., LANSING, MICH.	Тур.		Uni
Error Amplifier Section (Note 7	)	Or I V V		Rande	nos nov v	consideration of the considera
Input Offset Voltage	71777	$R_s \le 2K\Omega$ , E/A OUTPUT = 2.5V	Sales Sales	t nomine	20	m\
Input Bias Current		E/A OUTPUT = 2.5V		0.4	3	μA
Input Offset Current		E/A OUTPUT = 2.5V	Arithmed Barres	wishaum?	1.1	μA
DC Open Loop Gain	A <sub>VOL</sub>	E/A OUTPUT = 1 to 4V	60	100	2 40/2 \ 8	dE
Common Mode Rejection		Over Rated Voltage Range, E/A OUTPUT = 2.5V	75	110	anounia	d
Power Supply Rejection		V <sub>IN</sub> = 10V to 30V, E/A OUTPUT = 2.5V	85	100	anna sa	d
Output Sink Current		E/A OUTPUT = 1V	1	introduction	energe (	m/
Output Source Current		E/A OUTPUT = 4V	-0.5	-1.3	rysel vois	m
Output High Voltage		E/A OUTPUT = -0.5mA	4.0	4.85	5.0	V
Output Low Voltage		E/A OUTPUT = 1mA	0	0.6	1.0	V
Unity Gain Bandwidth (Note 4)		A <sub>vol</sub> = 0dB	3	5.5	MARKET WAS	MF
Slew Rate (Note 4)			6	12	len a malta	V/µs
PWM Comparator Section (Note	26 & 8)	A 1			2508	181
Ramp Input Bias Current	0 0 0, 0,	30.		-1	-5	L L/
Minimum Duty Cycle		E/A OUTPUT = 1V			0	9%
Maximum Duty Cycle (Note 9)		LX1823C/LX1823I, E/A OUTPUT = 4V	85			9%
Maximum Daty Cycle (Note 7)		LX1823M, E/A OUTPUT = 4V	80	HEW TOW	911101	9/
Zero Duty Cycle Threshold		Bridging Bridging 1	1.1	1.3		V
Delay to Driver Output (Note 4)		RAMP = 0V to 2V, E/A OUTPUT = 2V	S 10 10 10 10 10 10 10 10 10 10 10 10 10	1.0	80	n
Softstart Section	120 127 1 101	10 011 - 01 10 21, 111 0011 01 - 21	the state of the	lines -	- 00	1
ISSUED AND DESCRIPTION OF A PARTY OF THE PAR	SYDNUS, NOT SEE	SOFTSTART = 0.5V	3	7	20	1
Charge Current	DE BUILD STON	30110171K1 = 0.01		1	20	μ/
Discharge Current	0.0	SOFTSTART = 1.0V	1			m/
Current Limit / Shutdown Section	on (Note 10		Ben Cons	May Tab	100000	
I <sub>LIM</sub> /S.D. Input Bias Current		LX1823C only		101131	±10	µ/
9.05 5.10 5.15 V		LX1823M/LX1823I only			±15	μ/
I <sub>LIM</sub> REF Offset		I <sub>LIM</sub> REF = 1.1V			15	m
I <sub>LIM</sub> REF Common Mode Range		Amot of E = )	1.0		1.25	DacV
Shutdown Threshold		Over Operating Temporature	1.25	1.40	1.55	V
Delay to Driver Output (Note 4)		I <sub>LIM</sub> / S.D. = 0V to 2V	(4-50	pИ) sene	80	a n
Output Drivers Section (each of	output)					
Output Low Level		I <sub>SINK</sub> = 20mA	es 4 & 5	0.21	0.40	and V
		I <sub>SINK</sub> = 200mA		1.2	2.2	V
Output High Level		I <sub>SOURCE</sub> = 20mA	13.0	13.5	lator St	V
370 400 430 kH		$I_{SOURCE} = 200 \text{mA}$	12.0	13.0	ретираА	V
V <sub>c</sub> Standby Current		$V_{IN} = V_{C} = 30V$ VOE of 03 = .V		180	500	μ/
Output Rise / Fall Time (Note 4)		C <sub>L</sub> = 1000pF	(1-370)	30	60	n
Undervoltage Lockout Section		Over Line and Tomorpature	Note 4)	) ztímil y	onsuperion and a second	Isiol
Start Threshold Voltage		R_= 100MQ, C_= 0.01pF	8.80	9.35	9.80	IV
UV Lockout Hysteresis		R = 1800, C, = 4700F	0.4	0.8	1.2	V
Supply Current Section (Note 6	)	Amt- = pal		12	High Lev	Nooi
Start Up Current		V <sub>IN</sub> = 8V		460	1000	Lu/
Operating Current		INV. INPUT, RAMP, (I <sub>IIM</sub> /S.D.) = 0V, N.I. INPUT = 1V		24	33	m/

Note 9.  $V_{\rm CM} = 4.50$  to 5.5V.

Note 7.  $V_{\rm CM} = 1.5$  to 5.5V.

Note 8.  $V_{\rm RAMP} = 0$ V, unless otherwise specified.

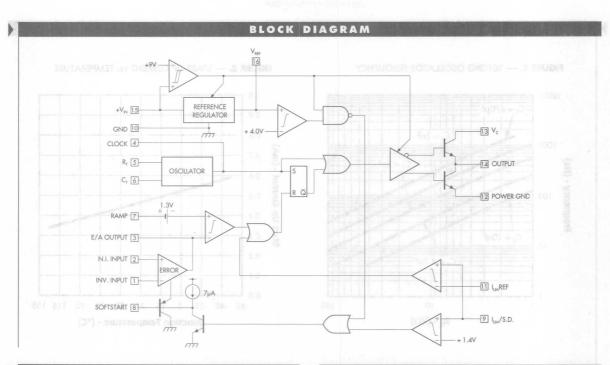
Note 9. 100% duty cycle is defined as a pulsewidth equal to one oscillator period.

Note 10.  $V(I_{IIM}/S.D.) = 0V$  to 4.0V, unless otherwise specified.



### HIGH-SPEED CURRENT-MODE PWM

### NOT RECOMMENDED FOR NEW DESIGNS

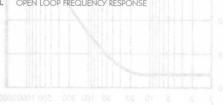


### **GRAPH / CURVE INDEX**

#### Characteristic Curves

#### FIGURE #

- 1. SETTING OSCILLATOR FREQUENCY
- 2. START-UP CURRENT vs. TEMPERATURE
- 3. OUTPUT DRIVER HIGH VS. I SOURCE
- OUTPUT DRIVER LOW VS. ISINK
- 5. OUTPUT DRIVER RISE / FALL TIME, 1nF
- 6. OUTPUT DRIVER RISE / FALL TIME, 10nF
- 7. UNITY GAIN SLEW RATE
- OPEN LOOP FREQUENCY RESPONSE

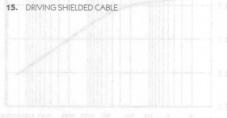


### FIGURE INDEX

### **Application Circuits**

#### FIGURE #

- 9. HIGH SPEED LAYOUT and BYPASSING
- 10. MICROPOWER STARTUP
- 11. SOFTSTART FAST RESET
- 12. OSCILLATOR SYCHRONIZATION
- 13. OSCILLATOR FUNCTIONAL DIAGRAM
- 14. VOLTAGE AMPLIFIER CONNECTIONS





### NOT RECOMMENDED FOR NEW DESIGNS

#### CHARACTERISTIC CURVES

FIGURE 1. — SETTING OSCILLATOR FREQUENCY

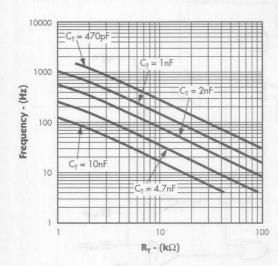


FIGURE 2. — START-UP CURRENT vs. TEMPERATURE

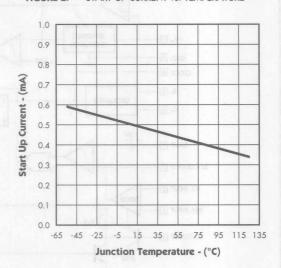


FIGURE 3. — OUTPUT DRIVER HIGH VS. I SOURCE

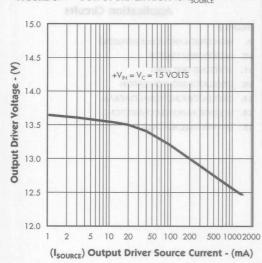
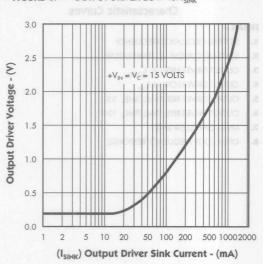


FIGURE 4. — OUTPUT DRIVER LOW vs. ISINK





### NOT RECOMMENDED FOR NEW DESIGNS

### CHARACTERISTIC CURVES

FIGURE 5. — OUTPUT DRIVE RISE / FALL TIME, 1nF

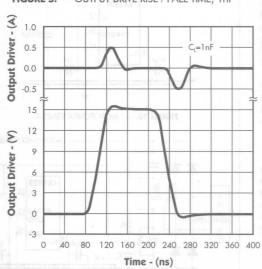


FIGURE 6. — OUTPUT DRIVER RISE / FALL TIME, 10nF

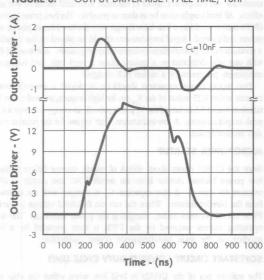


FIGURE 7. — UNITY GAIN SLEW RATE

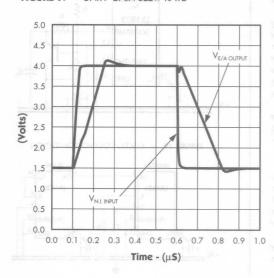
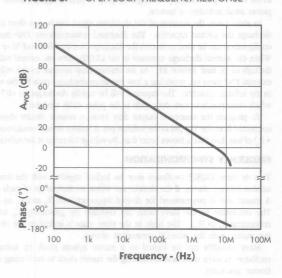


FIGURE 8. — OPEN LOOP FREQUENCY RESPONSE



### NOT RECOMMENDED FOR NEW DESIGNS

#### APPLICATION INFORMATION

#### HIGH-SPEED LAYOUT AND BYPASSING

The LX1823, like all high-speed circuits, requires extra attention to external conductor and component layout to minimize undesired inductive and capacitive effects. All lead lengths must be as short as possible. The best printed circuit board (PCB) choice would be a four-layer design, with the two internal planes supplying power and ground. Signal interconnects should be placed on the outside, giving a conductor-over-ground-plane (microstrip) configuration. A two-sided PC board with one side dedicated as a ground plane is next best, and requires careful component placement by a skilled PCB designer.

Two supply bypass capacitors should be employed: a low-inductance  $0.1\mu F$  ceramic within 0.25 inches of the  $V^{}_{\rm LN}$  pin for high frequencies, and a 1 to 5µF solid tantalum within 0.5 inches of the  $V^{}_{\rm C}$  pin to provide an energy reservoir for the high peak output currents. A low-inductance .01µF bypass for the reference output is also recommended.

#### MICROPOWER STARTUP

Since the LX1823 draws about 460 $\mu$ A of supply current before turning on, a low power bleeder resistor from the rectified AC line supply is all that is required for startup. A start capacitor,  $C_{sy}$  is charged with the excess current from the bleeder resistor. When the turn-on threshold voltage is reached, the PWM circuit becomes active, energizing the power transistors. The additional operating current required by the PWM is then provided by a bootstrap winding on the main high-frequency power transformer.

#### SOFTSTART CIRCUIT / OUTPUT DUTY CYCLE LIMIT

The softstart pin of the LX1823 is held low when either the chip is in the micropower mode, or when a voltage greater than +1.4 volts is present at the  $I_{LM}/S$ .D. pin. The maximum positive swing of the voltage error amplifier is clamped to the softstart pin voltage, providing a ramp-up of peak charging currents in the power semiconductors at turn-on.

In some cases, the duration of the shutdown signal can be too short to fully discharge the softstart capacitor. The illustrated resistor/discrete PNP transistor configuration can be used to shorten the discharge time by a factor of 50 or more. When the internal discharge transistor in the LX1823 turns on, current will flow through surge limit resistor R1. As the resistor drop approaches 0.6 volts, the external PNP turns on, providing a low resistance discharge path for the energy in the softstart capacitor. The capacitor will be rapidly discharged to +0.7 volts, which corresponds to zero duty cycle in the pulse width modulator.

To program the maximum output duty cycle, a resistor divider should be connected from the  $V_{\text{NEF}}$  pin to the softstart pin. A resistor divider combination ( $R_2$  +  $R_2$ ) of less than  $5k\Omega$  achieves better than 2% voltage tolerance at the softstart pin.

#### FREQUENCY SYNCHRONIZATION

Two or three LX1823 oscillators may be locked together with the interconnection scheme shown, if the devices are within an inch or so of each other. A master unit is programmed for desired frequency with  $R_{_{\! T}}$  and  $C_{_{\! T}}$  as usual. The oscillators in the slave units are disabled by grounding  $C_{_{\! T}}$  and by connecting  $R_{_{\! T}}$  to  $V_{_{\! REF}}$ . The logic in the slave units is locked to the clock of the master with the wire-OR connection shown.

Many LX1823's can be locked to a master system clock by wiring the oscillators as slave units, and distributing the master clock to each using a tree-fanout geometry.

### APPLICATION FIGURES

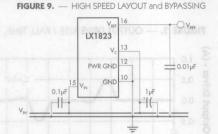


FIGURE 10. — MICROPOWER STARTUP

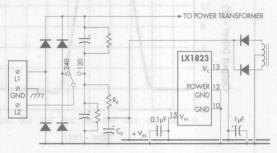


FIGURE 11. — SOFTSTART FAST RESET

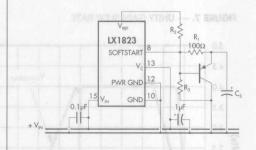
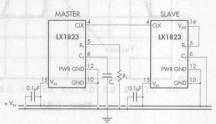


FIGURE 12. — OSCILLATOR SYCHRONIZATION





### NOT RECOMMENDED FOR NEW DESIGNS

#### APPLICATION INFORMATION

#### **OSCILLATOR**

The oscillator frequency is programmed by external timing components  $R_{_{\rm T}}$  and  $C_{_{\rm T}}$  A nominal +3 volts appears at the  $R_{_{\rm T}}$  pin. The current flowing through  $R_{_{\rm T}}$  is mirrored internally with a 1:1 ratio. This causes an identical current to flow out the  $C_{_{\rm T}}$  pin, charging the timing capacitor and generating a linear ramp. When the upper threshold of +2.7 volts is reached, a discharge network reduces the ramp voltage to +1.0 volts, where a new charge cycle begins.

The Clock output pin is LOW (+2.3 volts) during the charge cycle, and HIGH (+4.3 volts) during the discharge cycle. The Clock pin is driven by an NPN emitter follower, and so can be wire-ORed. Each Clock pin can drive a 1mA load. Since the internal current-source pulldown is approximately 400µA, the DC fan-out to other LX1823 Clock pins is at least two.

The type of capacitor selected for  $\mathrm{C_T}$  is very important. At high frequencies, non-ideal characteristics such as effective series resistance (ESR), effective series inductance (ESL), dielectric loss and dielectric absorption all affect frequency accuracy and stability. RF capacitors such as silver mica, glass, polystyrene, or COG ceramics are recommended. Avoid high-K ceramics, which work best in DC bypass applications.

#### ERROR AMPLIFIER

The voltage error amplifier is a true operational amplifier with low-impedance output, and can be gain-stabilized using conventional feedback techniques. The typical DC open-loop gain is 100dB, with a single low-frequency pole at 100Hz.

The input connections to the error amplifier are determined by the polarity of the power supply output voltage. For positive supplies, the common-mode voltage is set to the reference of +5.1 volts and the feedback connections in Figure 14A are used. With negative outputs, the common-mode voltage is half the reference, and the feedback divider is connected between the negative output and the +5.1V reference, shown in Figure 14B.

#### **OUTPUT DRIVER**

The output driver is designed to provide up to 2 Amps peak output current. To minimize ringing on the output waveform, which can be destructive to both the power MOSFET and the PWM chip, the series inductance seen by the drivers should be as low as possible.

One solution is to keep the distance between the PWM and MOSFET gate as short as possible, and to use carbon composition series damping resistors. A Faraday shield to intercept radiated EMI from the power transistors is usually required with this choice.

A second approach is to place the MOSFETs some distance from the PWM chip, and use a series-terminated transmission line to preserve drive pulse fidelity. This will minimize noise radiated back to the sensitive analog circuitry of the LX1823. A Faraday shield may also be required.

If the driver is connected to an isolation transformer, or if kickback through gate-to-drain capacitance of the MOSFET is severe, clamp diodes may be required. Use a 2 Amp peak Schottky diode to limit undershoot to less than -0.3 volts.

#### **APPLICATION FIGURES**

FIGURE 13. — OSCILLATOR FUNCTIONAL DIAGRAM

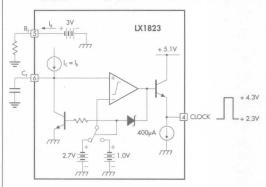


FIGURE 14. — VOLTAGE AMPLIFIER CONNECTIONS

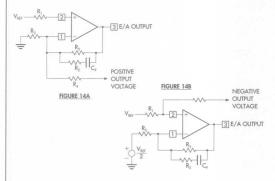
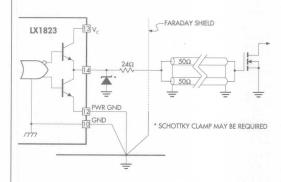


FIGURE 15. — DRIVING SHIELDED CABLE



#### SIGTALIESE

The oscillator inquency is programmed by exercical tuning compensation R, and C., a norshool +5 web appears at the R, pin. The current flowlood program is R, is minored internally with a 1th pano. This convex an oceanical concers to librar out the C, pin, changing the timing capacion and generality a linear ramp. When the upper timeshold of +27 volts in particular, a discharge to +1.0 volts, where a new change cycle where it now change cycle.

The Clock output pin it iOW (+2.3 who during the charge rivide and MIRCH (+4.3 vols.) during the declaring order. The Clock pin is direct to no MIRCH central takewer, and so can be wise-Obed. Each Cook pin can shave in IBBA lock. Since the internal concentrations, publishers, as approximately

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#### BUILDING ANDRES

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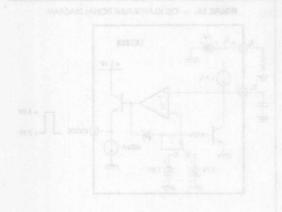
#### REVISIO TORPUO

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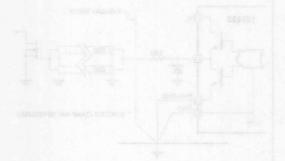
A second suproach is to place the MASH is some distinct founding PASH office, and use a secret-reminated transmission has to greener, direct pather fidelity. This will minimize noise radiated look to the sensitive routing

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BURAD CROUDING SHIPLDED CARLE





800mA Low Dropout Source And Sink 2.85V REGULATOR

THE INFINITE POWER OF INNOVATION

PRELIMINARY DATA SHEET

#### DESCRIPTION

The LX5285 is a low dropout fixed voltage source and sink regulator designed specifically for the Small Computer Systems Interface (SCSI) alternative 2 active termination. It is compatible with SCSI-1, SCSI-2, SCSI-3 and FAST-20 standards for both narrow and wide SCSI applications. The LX5285's (400mA) sink current capability make it compatible with active negation drivers without having to add external clamping components. Since the LX5285 is sink and source there is no deadband associated with the sink current capability (unlike many

clamps) which keeps the signal line voltage lower giving greater noise margin upon assertion.

The LX5285's 1.2V maximum dropout ensures compatibility with existing SCSI systems. The  $\pm 1\%$  maximum tolerance on the 2.85V output voltage ensures a tighter line driver current tolerance, thereby increasing system noise margin.

The LX5285 is packaged in a SOT-223 surface-mount package that offers low thermal resistance.

#### **KEY FEATURES**

- 2.85V FIXED OUTPUT FOR SCSI ACTIVE TERMINATION
- COMPATIBLE WITH SCSI-1, SCSI-2, SCSI-3, AND FAST-20
- ACTIVE NEGATION COMPATIBLE
- SPACE SAVING SOT-223 PACKAGE
- OUTPUT SOURCE CURRENT 800mA
- 1.2V MAXIMUM DROPOUT VOLTAGE AT I<sub>O</sub> = -800mA
- ±1% MAXIMUM OUTPUT TOLERANCE AT T.=25°C
- ±2% ABSOLUTE OUTPUT VARIATION
- INTERNAL OVERCURRENT LIMITING CIRCUITRY
- INTERNAL THERMAL OVERLOAD PROTECTION

#### PRODUCT HIGHLIGHT LX5285 BLOCK DIAGRAM 110Ω Fuse 1% $V_{LOGIC}$ $V_{\text{TERM}}$ V<sub>0</sub>=2.85V IN OUT DB (0) DB (1) C2\* C1 2.2µF 1/0 10µF LX5285 Reg C/D SEL GND MSG RST ACK BSY \* C1 & C2: Sanyo 25SC02R2M & 25SC10R0M Tantalum capacitors recommended. Minimum capacitance for regulator stability. ATN PACKAGE ORDER INFORMATION ST Plastic S0T-223 TA (°C) 3-pin 0 to 70 LX5285CST Note: Available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5285CSTT)

### 800mA Low Dropout Source And Sink 2.85V Regulator

### TARRES ATA O MAR PRELIMINARY DATA SHEET

### 

The  $\theta_{tx}$  numbers are guidelines for the thermal performance of the device/pc-board system.

PACKAGE PIN OUTS

3. IN

2. GND

1. OUT

ST PACKAGE
(Top View)

### RECOMMENDED OPERATING CONDITIONS (Note 2)

Parameter	Symbol Recommended Operating Cond				
Faralleter	Symoon	Min.	Тур.	Max.	Units
Input Capacitor		2.2			μF
Output Capacitor		10	Vanne		μF
Input Voltage (0) 80	O NI MI	4.1		7	V
Operating Ambient Temperature Range		0		70	°C

Note 2. Range over which the device is functional

Junction Temperature Calculation:  $T_1 = T_A + (P_D \times \theta_{1A})$ .

All of the above assume no ambient airflow.

### **ELECTRICAL CHARACTERISTICS**

(Unless otherwise specified, T, = 25°C.)

Parameter	Symbol	bol Test Conditions		LX5285		
Falailletei	Sylliooi	lest collations	Min.	Тур.	Max.	Units
Output Voltage	V <sub>out</sub>	$I_{OUT} = -10 \text{mA}, V_{IN} = 4.75 \text{V}$	2.82	2.85	2.88	٧
	WV+	$0.4A < I_{OUT} < -0.8A, V_{IN} = 4.25V$	2.79	2.85	2.91	٧
		0.4A < I <sub>OUT</sub> < -0.5A, V <sub>IN</sub> = 4.1V	2.79	2.85	2.91	٧
Line Regulation	N M	$I_{OUT} = 0, 4.1 V < V_{IN} < 7 V$			6	mV
Load Regulation	anne	$0.4A > I_{OUT} > -0.8A, V_{IN} = 4.25V$			10	mV
Dropout Voltage	V <sub>DO</sub>	I <sub>OUT</sub> = -100mA			1.1	V
v88Y	11/1	I <sub>OUT</sub> = -0.8A	The same of		1.2	٧
Current Limit	ILIM	$V_{IN} - V_{O} = 3V$ , $I_{LSOURCE}$		-1000		mA
	N. W.	$V_{IN} - V_{O} = 3V$ , $I_{LSINK}$	500			mA
Supply Current	Icc	4.25V < V <sub>IN</sub> < 5.25V, No Load		6	10	mA
Short Circuit Current	I <sub>SL</sub>	$V_{OUT} = OV, I_{SC}$	800	la series		mA
		$V_{OUT} = V_{INI} I_{SC+}$	500			mA
Thermal Regulation		T <sub>A</sub> = 25°C, 30mS Pulses			0.1	%/W
Thermal Shutdown		T PC 123 Plastic 301-223		165		°C
Ripple Rejection		F Ripple= 120Hz, 0.5V <sub>P-P</sub>	60	80		dB
Temp Drift		0°C < T <sub>j</sub> < 125°C			0.5	%
Output Noise		(% of V <sub>OUT</sub> ), 10Hz < 10kHz	Para la		0.003	%

### 800mA Low Dropout Source And Sink 2.85V Regulator

### PRELIMINARY DATA SHEET

### GRAPH / CURVE INDEX

#### **Characteristic Curves**

#### FIGURE #

- 1. DROPOUT vs. OUTPUT CURRENT
- 2. GROUND CURRENT vs. SOURCE CURRENT
- 3. LOAD REG vs. TEMPERATURE
- 4. OUTPUT Z vs. FREQUENCY
- 5. SUPPLY CURRENT vs. TEMPERATURE
- 6. LOAD TRANSIENT RESPONSE
- 7. INPUT CURRENT vs. SINK CURRENT



**C**LINFINITY





### TRANSIENT IMMUNE UNDERVOLTAGE SENSING CIRCUIT

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

### DESCRIPTION

The LX7001 is an improved undervoltage sensing circuit specifically designed for use as a reset controller in microprocessor-based systems. Today's complex miniaturized systems present difficult challanges to the system designer such as overcoming spurious noise problems. The LX7001 is optimized for systems that must be tolerant of high-speed power supply glitches caused by high-speed logic transitions and similar switching phenomena. The LX7001 offers a unique stage that couples glitch immunity with a micropower, ultrastable band-gap reference for precision sensing of undervoltage conditions. It offers the designer an

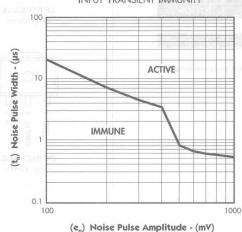
economical, space-efficient solution for low supply voltage detection when used in combination with a single pull-up resistor. Adding one capacitor offers the functionality of a programmable delay time after power returns. Additionally, the LX7001 offers excellent temperature stability. A high-quality trimmed voltage reference and bias circuit permit very accurate and repeatable undervoltage sensing. The remaining blocks consist of a comparator with hysteresis, high current clamping diode and open collector output stage capable of sinking up to 60mA. The LX7001's RESET output is specified to be fully functional at V<sub>IN</sub>=1V.

#### KEY FEATURES

- FULLY CHARACTERIZED, TRANSIENT IMMUNE INPUT STAGE
  (See Product Highlight)
- MONITORS 5V SUPPLIES (V<sub>трір</sub>=4.6V typ)
- OUTPUTS FULLY DEFINED AT V<sub>cc</sub>=1V
- ULTRA-LOW SUPPLY CURRENT (500µa max. over temp)
- TEMPERATURE COMPENSATED I<sub>CC</sub> FOR EXTREMELY STABLE CURRENT CONSUMPTION
- □ µP RESET FUNCTION PROGRAMMABLE WITH 1 EXTERNAL RESISTOR AND CAPACITOR
- □ COMPARATOR HYSTERESIS PREVENTS OUTPUT OSCILLATION
- ELECTRICALLY COMPATIBLE WITH MOTOROLA MC34064
- □ PIN-TO-PIN COMPATIBLE WITH MOTOROLA MC34064/MC34164

#### PRODUCT HIGHLIGHT

#### INPUT TRANSIENT IMMUNITY



### APPLICATIONS

- ALL MICROPROCESSOR OR MICROCONTROLLER DESIGNS USING 5V SUPPLIES
- SIMPLE 5V UNDERVOLTAGE DETECTION

	PACK	AGE ORDER II	NFORMATION	
T <sub>A</sub> (°C)	DM Plastic SOIC 8-pin	LP Plastic TO-92 3-pin	PK Plastic SOT-89 3-pin	Y Ceramic Dip 8-pin
0 to 70	LX7001CDM	LX7001CLP	LX7001CPK	_
-40 to 85	LX7001IDM	LX7001ILP	LX7001IPK	_
-55 to 125	_	_	_	LX7001MY

 $Note: \ All \ surface-mount \ packages \ are \ available \ in \ Tape \ \& \ Reel. \ Append \ the \ letter \ "T" \ to \ part \ number. \ (i.e. \ LX7001CDMT)$ 

### TRANSIENT IMMUNE UNDERVOLTAGE SENSING CIRCUIT

### TRANSPORTATION PRODUCTION DATA SHEET

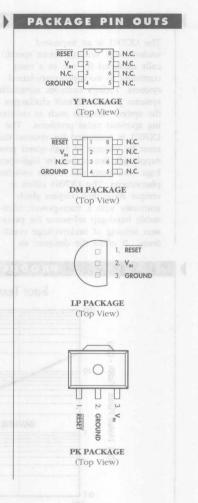
### 

Note 1. Values beyond which damage may occur. All voltages are specified with respect to ground, and all currents are positive into the specified terminal.

THERMAL DATA	
DM PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{J_A}}$	165°C/W
LP PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{J_A}}$	156°C/W
PK PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{_{\mathrm{JT}}}$	35°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{J_A}}$	71°C/W
Y PACKAGE: 10 SELECTION OF SECURITY OF SEC	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	130°C/W
Junction Temperature Calculation: $T_J = T_A + (P_D \times \theta_{JA})$ .	

The  $\theta_{tA}$  numbers are guidelines for the thermal performance of the device/pc-board system.

All of the above assume no ambient airflow



### TRANSIENT IMMUNE UNDERVOLTAGE SENSING CIRCUIT

### PRODUCTION DATA SHEET

RECOM	MENDED OPE	RATING C	ONDITION	<b>S</b> (Note 2)			
		Recommended Operating Conditions				Units	
Parameter		Symbol	Min.	Typ. Max.		Units	
Input Supply Voltage	1 1 1 1	V <sub>IN</sub>	1		10	V	
RESET Output Voltage		V <sub>out</sub>		10		V	
Clamp Diode Forward Current		I <sub>E</sub>	31	50mA			
Operating Ambient Temperature Range:	3	4				10.00	
LX7001C			0		70	°C	
LX7001I			-25		85	°C	
LX7001M			-55		125	°C	

Note 2. Range over which the device is functional.

#### **ELECTRICAL CHARACTERISTICS**

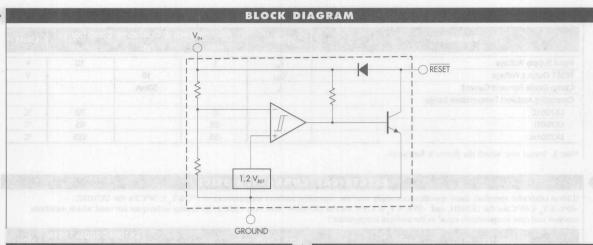
(Unless otherwise specified, these specifications apply over the operating ambient temperatures of  $0^{\circ}\text{C} \le \text{T}_{\Lambda} \le 70^{\circ}\text{C}$  for the LX7001C,  $-40^{\circ}\text{C} \le \text{T}_{\Lambda} \le 85^{\circ}\text{C}$  for the LX7001I, and  $-55^{\circ}\text{C} \le \text{T}_{\Lambda} \le 125^{\circ}\text{C}$  for the LX7001M. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX7001	C/7001I	7001M	Unit
			Min.	Тур.	Max.	
Comparator Section						
Threshold Voltage	PCA.	49Y62 D68	Su and the	0.0		
High State Output	V <sub>T+</sub>	V <sub>IN</sub> Increasing — 4V to 5V	4.5	4.62	4.7	V
Low State Output	V <sub>T</sub> .	V <sub>IN</sub> Decreasing — 5V to 4V	4.5	4.60	4.7	٧
Hysteresis	V <sub>H</sub>	ENGINEERS AND STREET	0.01	0.02	0.05	٧
RESET Output Section	0.000	AND THE PROPERTY OF THE PROPER			TO THE PARTY OF	100
Output Sink Saturation Voltage		$V_{IN} = 4.0V, I_{OL} = 8.0 \text{mA}$	200	0.06	1.0	٧
	V <sub>OL</sub>	$V_{IN} = 4.0V, I_{OL} = 2.0 \text{mA}$	CELL PER SE	0.25	0.4	٧
	DEDIM 36	$V_{IN} = 1.0V, I_{OL} = 0.1 \text{mA}$	24 SISS	0.3	0.1	٧
Output Sink Current	loL	V <sub>OUT</sub> = 4.0V	10	40	60	mA
Output Off-State Leakage	I <sub>OH</sub>	V <sub>OUT</sub> = 5.0V	RESIMEST	0.01	0.5	μA
		V <sub>out</sub> = 10V	seargul 15	0.02	2.0	μА
Clamp Diode Forward Voltage	V <sub>F</sub>	Pin 1 to pin 2, I <sub>F</sub> = 10mA	0.6	0.82	1.2	٧
Total Device		Transfer to the Straig Prop St	Ca-Dollaron	TO HOU	TO CENT	07 - 450
Supply Current	I <sub>cc</sub>	$V_{IN} = 5.0V$	1000000	345	500	μA

# LX7001

# TRANSIENT IMMUNE UNDERVOLTAGE SENSING CIRCUIT

#### PRODUCTION DATA SHEET



## **GRAPH / CURVE INDEX**

#### **Characteristic Curves**

#### FIGURE #

- 1. RESET OUTPUT VOLTAGE vs. INPUT VOLTAGE
- 2. POWER-UP RESET VOLTAGE
- 3. RESET OUTPUT VOLTAGE vs. INPUT VOLTAGE
- 4. THRESHOLD VOLTAGE vs. TEMPERATURE
- 5. THRESHOLD HYSTERESIS vs. TEMPERATURE
- 6. SUPPLY CURRENT vs. INPUT VOLTAGE
- 7. SUPPLY CURRENT vs. TEMPERATURE
- 8. LOW LEVEL OUTPUT CURRENT vs. TEMPERATURE
- 9. LOW LEVEL OUTPUT VOLTAGE vs. LOW LEVEL OUTPUT CURRENT
- 10. VOLTAGE vs. CLAMP DIODE FORWARD CURRENT
- 11. PROPAGATION DELAY
- 12. LOW LEVEL OUTPUT VOLTAGE vs. TEMPERATURE

## FIGURE INDEX

# **Application Circuits**

#### FIGURE #

- 13. LOW VOLTAGE MICROPROCESSOR RESET
- 14. SWITCHING THE LOAD OFF WHEN BATTERY REACHES BELOW 4.3V
- 15. VOLTAGE MONITOR
- 16. MOSFET LOW VOLTAGE GATE DRIVE PROTECTION
- 17. LOW VOLTAGE MICROPROCESSOR RESET with ADDITIONAL HYSTERESIS



# TRANSIENT IMMUNE UNDERVOLTAGE SENSING CIRCUIT

PRODUCTION DATA SHEET

#### CHARACTERISTIC CURVES

FIGURE 1. — RESET OUTPUT VOLTAGE vs. INPUT VOLTAGE

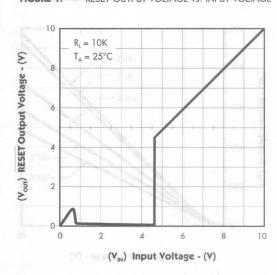


FIGURE 2. — POWER-UP RESET VOLTAGE

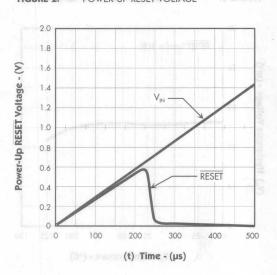


FIGURE 3. — RESET OUTPUT VOLTAGE vs. INPUT VOLTAGE

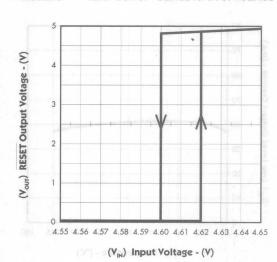
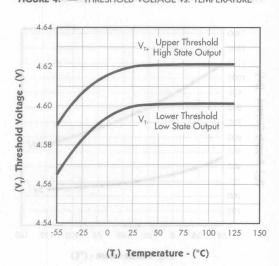


FIGURE 4. — THRESHOLD VOLTAGE vs. TEMPERATURE



# LX7001

# TRANSIENT IMMUNE UNDERVOLTAGE SENSING CIRCUIT

## PRODUCTION DATA SHEET

# CHARACTERISTIC CURVES

FIGURE 5. — THRESHOLD HYSTERESIS vs. TEMPERATURE

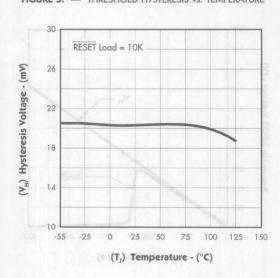


FIGURE 6. — SUPPLY CURRENT VS. INPUT VOLTAGE

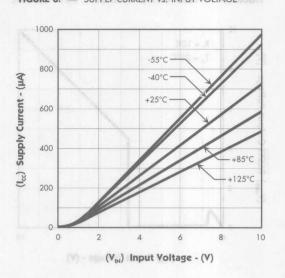


FIGURE 7. — SUPPLY CURRENT vs. TEMPERATURE

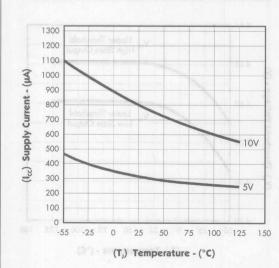
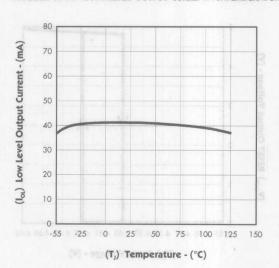


FIGURE 8. — LOW LEVEL OUTPUT CURRENT vs. TEMPERATURE



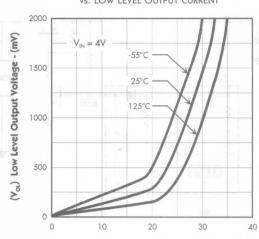


# TRANSIENT IMMUNE UNDERVOLTAGE SENSING CIRCUIT

PRODUCTION DATA SHEET

#### CHARACTERISTIC CURVES

FIGURE 9. — LOW LEVEL OUTPUT VOLTAGE
vs. LOW LEVEL OUTPUT CURRENT



(I<sub>SINK</sub>) Low Level Output Current - (mA)

FIGURE 11. — PROPAGATION DELAY

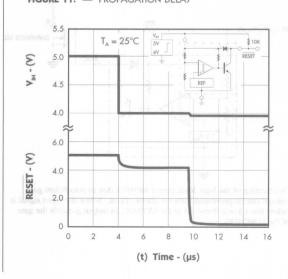


FIGURE 10. — VOLTAGE vs. CLAMP DIODE FORWARD CURRENT

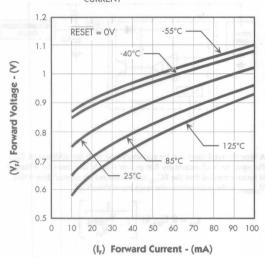
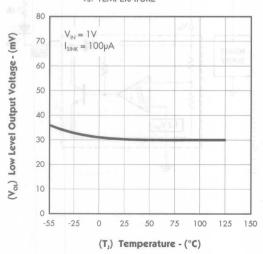


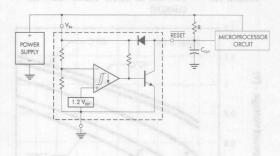
FIGURE 12. — LOW LEVEL OUTPUT VOLTAGE vs. TEMPERATURE



## PRODUCTION DATA SHEET

#### TYPICAL APPLICATION CIRCUITS

FIGURE 13. — LOW VOLTAGE MICROPROCESSOR RESET.



A time delayed reset can be accomplished with the addition of  $C_{\rm DLV}$ . For systems with extremely fast power supply rise times (< 500ns) it is recommended that the RC<sub>DLY</sub> time constant be greater than 5.0 $\mu$ s.  $V_{\text{THOMPID}}$  is the microprocessor reset input threshold.

$$t_{DLY} = R C_{DLY} \ln \left[ \frac{1}{1 - \frac{V_{TH[MPU]}}{V_{IN}}} \right]$$

FIGURE 15. — VOLTAGE MONITOR.

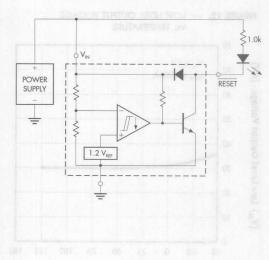


FIGURE 14. — SWITCHING THE LOAD OFF WHEN BATTERY REACHES BELOW 4.3V.

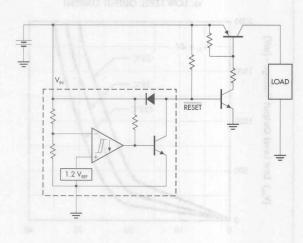
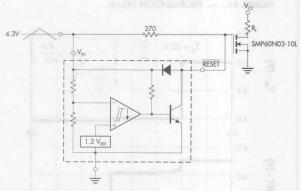


FIGURE 16. — MOSFET LOW VOLTAGE GATE DRIVE PROTECTION.



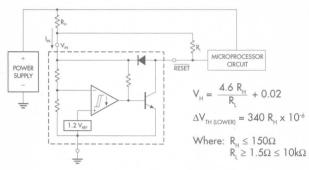
Overheating of the logic level power MOSFET due to insufficient gate voltage can be prevented with the above circuit. When the input signal is below the 4.3 volt threshold of the LX7001C, its output grounds the gate of the L2 MOSFET.

# TRANSIENT IMMUNE UNDERVOLTAGE SENSING CIRCUIT

# PRODUCTION DATA SHEET

#### TYPICAL APPLICATION CIRCUITS (Con't.)

FIGURE 17. — LOW VOLTAGE MICROPROCESSOR RESET with ADDITIONAL HYSTERESIS.



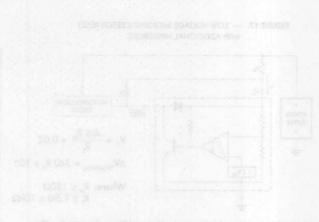
Comparator hysteresis can be increased with the addition of resistor  $R_{\rm H}$ . The hysteresis equation has been simplified and does not account for the change of input current  $I_{\rm IN}$  as  $V_{\rm CC}$  crosses the comparator threshold. An increase of the lower threshold  $\Delta V_{\rm TH \; LOWERO}$  will be observed due to  $I_{\rm IN}$  which is typically 340µA at 4.59V. The equations are accurate to  $\pm 10\%$  with  $R_{\rm H}$  less than  $150\Omega$  and  $R_{\rm L}$  between  $1.5k\Omega$  and  $10k\Omega$ .

	TEST	DATA	
(mV)	ΔV <sub>TH</sub> (mV)	R <sub>H</sub> (Ω)	$R_{L}$ $(\Omega)$
20	0	0	0
51	3.4	10	1.5
40	6.8	20	4.7
81	6.8	20	1.5
71	10	30	2.7
112	10	30	1.5
100	16	47	2.7
164	16	47	1.5
190	34	100	2.7
327	34	100	1.5
276	51	150	2.7
480	51	150	1.5

# Notes

PRODUCTION DATA SHIET





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# 5V SUPPLY VOLTAGE SUPERVISOR WITH REFERENCE

THE INFINITE POWER OF INNOVATION

PRELIMINARY DATA SHEET

#### DESCRIPTION

The LX7705 series of voltage supervisory circuits are greatly improved monolithic integrated circuits for microprocessor and microcontroller supervisory applications. Addressing today's low voltage systems, the LX7705 monitors a 5V supply voltage with full operation at a minimum  $\rm V_{\rm CC}$  level of 3.6V. Additionally, to prevent unknown or unwanted states, the RESET and RESET-BAR outputs are fully defined at the 1V level during power-up and power-down sequences. For today's "Green" systems, the LX7705 consumes only 1.4mA of quiescent current, offering a 60% improvement over competing products.

Operationally, the LX7705 monitors the supply voltage at the sense input. As the power supply voltage dips below the threshold voltage of 4.55V, the device generates a RESET-BAR signal for the microprocessor. The output will remain low until the power supply voltage returns to within specified values and the programmed delay has expired. The delay

is fully programmable by the user with a single external capacitor. The time delay is calculated by the following formula:

$$t_{\rm p} = 1.25 \times 10^4 \times C_{\rm r}$$

where  $C_T$  is in Farads (F) and  $t_D$  is in seconds.

Power-up sequencing is assisted by the LX7705 as its outputs are in a fully known low state once the power supply voltage exceeds 1V. During power-down, the outputs are also defined until the supply reaches 1V. Below 1V, the outputs are in an undefined state.

Improvements such as reduced propagation delay times, sharp output rise and fall times, and ultra-low leakage outputs, make the LX7705 the supply voltage supervisor of choice for all microprocessor and microcontroller applications. Functionally, the LX7705 also eliminates the need for a bypass capacitor on the Reference Output pin.

#### KEY FEATURES

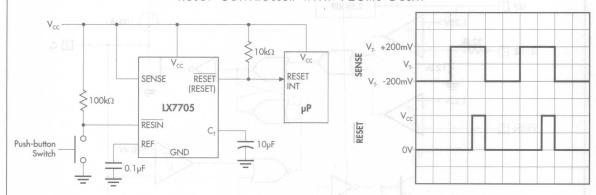
- MONITORS 5V SUPPLIES
- $\Box$  OUTPUT FULLY DEFINED AT  $V_{CC} = 1V$  $\Box$  IMPROVED OUTPUT LEAKAGE < 10 $\mu$ A
- IMPROVED OUTPUT LEARAC
- LOW 1.4mA TYPICAL I<sub>CC</sub>
- $\blacksquare$  RESET TF = 15ns typ.
- 2.5V EXTERNAL 30mA REFERENCE
- PROGRAMMABLE RESET DELAY
- ☐ TRUE / COMPLIMENTARY OUTPUTS
- EXTERNAL TRIGGERED RESET INPUT
- ☐ UPGRADED COMPATIBLE WITH TL7705A
- ELIMINATES NEED FOR CAPACITOR ON REF PIN

#### APPLICATIONS

ALL MICROPROCESSOR- AND MICROCONTROLLER-BASED DESIGNS

#### PRODUCT HIGHLIGHT

#### RESET CONTROLLER WITH 125MS DELAY



100ms / Div.

#### PACKAGE ORDER INFORMATION

T <sub>A</sub> (°C)	M Plastic DIP 8-pin	DM Plastic SOIC 8-pin
0 to 70	LX7705CM	LX7705CDM
-40 to 85	LX7705IM	LX7705IDM

Note: All surface mount packages are available in Tape & Reel, append the letter "T" to part number (i.e. LX7705CDMT).

#### FOR FURTHER INFORMATION CALL (714) 898-8121

## TRANS ANA O YMAN PRELIMINARY DATA SHEET

# ABSOLUTE MAXIMUM RATINGS (Note 1) Supply Voltage (V<sub>CC</sub>) 15V Input Voltage Range (RESIN) -0.3V to V<sub>CC</sub> Input Voltage Range (SENSE) -0.3V to V<sub>CC</sub> High-Level Output Current (RESET) -100mA Low-Level Output Current (RESET) 30mA Operating Junction Temperature Plastic (M & DM Packages) 150°C Storage Temperature Range -65°C to 150°C Lead Temperature 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

#### THERMAL DATA

#### M PACKAGE:

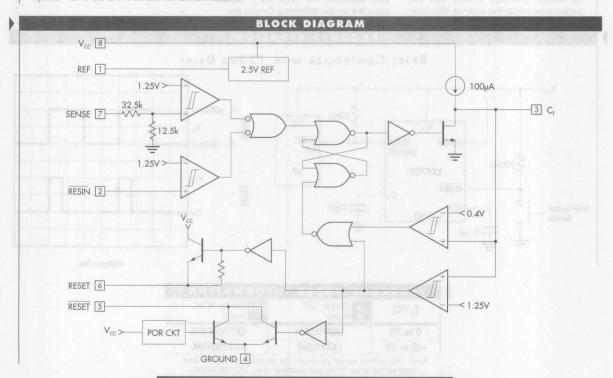
THERMAL RESISTANCE-JUNCTION TO AMBIENT,  $\theta_{\rm JA}$  95°C/W

DM PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT,  $\theta_{\rm JA}$  165°C/W

Junction Temperature Calculation:  $T_J = T_A + (P_D \times \theta_{JA})$ . The  $\theta_{JA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

## 



# 5V SUPPLY VOLTAGE SUPERVISOR WITH REFERENCE

# PRELIMINARY DATA SHEET

THE RESERVE OF THE PROPERTY OF THE PERSON OF	Symbol	Recommen	ded Operating	Conditions	Units
Parameter	Symool	Min. Typ.		Max.	Units
Supply Voltage	V <sub>cc</sub>	3.6	W 301/32	12	V
High-Level Input Voltage at RESIN	V <sub>IH</sub>	2	A		V
Low-Level Input Voltage at RESIN	V <sub>IL</sub>			0.8	٧
Input Voltage (SENSE)	V <sub>1</sub>	0		10	٧
Output Current At REF	lout		(V22.11-	30	mA
High-Level Output Current (RESET)	I <sub>OH</sub>			-16	mA
Low-Level Output Current (RESET)	loL	1	-1-(VBV	16	mA
Capacitor Selection At REF					
Minimum Range		0	N	100	pF
Maximum Range		0.1	- managements	10	μF
Operating Free-Air Temperature Range:			\$ 1301M		156
LX7705C	TA	0	LugiuO	70	°C
LX7705I	T,	-40		85	°C

Note 2. Range over which the device is functional.

#### **ELECTRICAL CHARACTERISTICS**

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for LX7705C with  $0^{\circ}C \le T_{A} \le 70^{\circ}C$ , LX77051 with  $-40^{\circ}C \le T_{A} \le 85^{\circ}C$ .)

Parameter	Symbol	Test Conditions (Note 3)		LX7705		Units
r arameter	Syllioui	rest colluitions (Note 3)	Min.	Тур.	Max.	Onics
Power-Up Reset Voltage	V <sub>RES</sub>	I <sub>OL</sub> (RESET) = 2mA, See Note 5	MEAN SOLES	Man, Indian	1	٧
High-Level Output Voltage (RESET)	V <sub>OH</sub>	I <sub>OH</sub> = -16mA	V <sub>cc</sub> - 1.5			٧
Low-Level Output Voltage (RESET)	V <sub>OL</sub>	I <sub>OL</sub> = 16mA			0.4	V
Reference Voltage (REF)	V <sub>REF</sub>	T <sub>A</sub> = 25°C, I <sub>OUT</sub> = No Load	2.48	2.53	2.58	V
Negative-Going Threshold Voltage (SENSE)	V <sub>T</sub>	$T_A = 25$ °C	4.5	4.55	4.6	٧
Hysteresis (V <sub>T+</sub> - V <sub>T-</sub> ) (SENSE)	V <sub>HYS</sub>	$T_A = 25$ °C	3000.0	15	1340 FE	mV
Input Current (RESIN)	I <sub>1</sub>	$V_1 = 2.4V \text{ to } V_{cc}$	AND WILL SV	D TWEET	0 1 30	μА
		V <sub>1</sub> = 0.4V	SAN DE TONO	KORVALIDA	SI -1\0.	μА
High-Level Output Current (RESET)	I <sub>OH</sub>	V <sub>O</sub> = 12V	and any south	MCSTA II	10	μА
Low-Level Output Current (RESET)	loL	$V_{o} = OV$	twister	in make	-10	μА
Supply Current	I <sub>cc</sub>	SENSE = 4.75V and outputs open		1.4	2	mA
Minimum Pulse Duration at SENSE	t <sub>ws(MIN)</sub>	$V_{IH} = V_{T-} + 200 \text{mV}$	- NO3 15	0.1	V1 13149	μs
Inputs to Switch Outputs		$V_{IL} = V_{T-} - 200 \text{mV}$	NATIONAL PROPERTY	0.1	OV WILL	μs
Propagation Delay Time from RESIN to RESET	t <sub>PD</sub>	$V_{cc} = 5V$	AMERICA STATE	0.3	R) XX (B)	μs
SENSE to RESET		V <sub>cc</sub> = 5V	ON THE STREET	0.3	ST SAILS	μs
Rise Time (Note 4)	t <sub>e</sub>	RESET, V <sub>cc</sub> = 5V	off asservation	15	Dazu I	ns
		RESET, V <sub>cc</sub> = 5V		280		ns
Fall Time (Note 4)	t <sub>r</sub>	RESET, $V_{cc} = 5V$	THE RESIDENCE	220	1.52 -1.523	ns
		$\overline{RESET}$ , $V_{CC} = 5V$	THE CHIESES	15	Dr. Schigt	ns

Note 3. All electrical characteristics are measured with 0.1 $\mu F$  capacitors connected at REF,  $C_{_T}$  and  $V_{_{CC}}$  to GND.

Note 4. The rise and fall times are measured with a  $4.7 k\Omega$  load resistor at RESET and RESET. (O

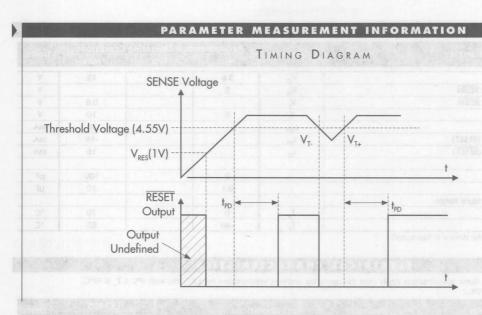
Note 5. The lowest supply voltage at which  $\overline{\text{RESET}}$  becomes active.



# LX7705

# 5V SUPPLY VOLTAGE SUPERVISOR WITH REFERENCE

## PRELIMINARY DATA SHEET



## GRAPH / CURVE INDEX

#### **Characteristic Curves**

#### FIGURE #

- 1. THRESHOLD Over TEMPERATURE
- 2. V<sub>PFF</sub> Over TEMPERATURE
- 3. SUPPLY CURRENT Over TEMPERATURE
- 4. LOAD REGULATION Over TEMPERATURE
- 5. LINE REGULATION Over TEMPERATURE
- 6. V<sub>REF</sub> Over LOAD CURRENT
- 7. RESET VOLTAGE OVER LOAD CURRENT
- 8. REBAR VOLTAGE Over LOAD CURRENT
- 9. REBAR (& RESET) POWER-DOWN CONDITION
- 10. REBAR (& RESET) POWER-UP CONDITION
- 11. C, CHARGING CURRENT Over TEMPERATURE
- 12. RESIN TO REBAR (& RESET) OUTPUT DELAY
- 13. SENSE TO REBAR (& RESET) OUTPUT DELAY
- 14. REBAR (& RESET) OUTPUT RISE / FALL TIME OUTPUT OFF
- 15. REBAR (& RESET) OUTPUT FALL / RISE TIME OUTPUT ON





# LX8020-xx/8020A-xx

ULTRA LOW DROP OUT REGULATOR (ULDO™)

THE INFINITE POWER OF INNOVATION

PRELIMINARY DATA SHEET

#### DESCRIPTION

The LX8020-xx/8020A-xx series of Ultra-Low Drop Out (ULDOTM) Voltage Regulators is the latest advance in highly efficient power supply products for battery operated systems. Using the LX8020-xx/8020A-xx in your equipment design provides a significant advantage in operating efficiency, resulting in longer system operating life. See the System Up-Time Figure featured below. A newly-patented design technique coupled with Linfinity BiCMOS wafer process technology not only delivers efficiency but space savings, too! Unlike most LDO's that require bulky compensation capacitors, the LX8020xx/8020A-xx series is very stable over no-load to full-load conditions using 0603 surface-mount Z5U 0.1µF output/ input capacitors. See the Application Notes at the end of this document for assistance in selecting the best capacitor for your application.

The patented CMOS pass element design technique delivers a lot more than high efficiency. A key advantage to this technique is constant quiescent operating current over the full-load range of the device. Unlike bipolar equivalents, which require increasing base drive with increasing loads, the LX8020-xx/8020A-xx is totally independent. Plus, the LX8020-xx/ 8020A-xx does not exhibit the unwieldy high-current demands of a bipolar device entering the drop out region (saturation phenomena). For example, for a given pass element (typ. a pnp transistor) load, there is a larger than normal amount of stored charge in the

base region. This results in a larger base current contribution to the load. In addition, since the base-collector junction is now forward biased, there is a new base current contribution due to injection of carriers from the base to the collector. The combination of these two events results in a base current which is substantially larger during drop-out, resulting in increased device operating current. This term is commonly referred to as forced beta. Additionally, as load demands increase, the forced beta condition worsens. The event occurs at the time when your system least wants or needs increasing current demands, at the end of battery

Another unique feature of the LX8020-xx/8020A-xx delivers is superb Line and Load regulation from DC out to extraordinarily high frequencies. This is very important for systems which have continuously varying load and line conditions. The clear advantage of excellent AC response is the overall reduction in output capacitor size and value. Using the LX8020-xx/8020A-xx family of ULDO's in size, weight and power sensitive applications enhances your applications performance beyond yesterday's bipolar solutions.

Other advantages the LX8020-xx/8020A-xx offers include current limiting, thermal protection and reverse battery (no battery) protection. The LX8020-xx/8020A-xx Family is offered in a variety of output voltage and packaging options.

#### KEY FEATURES

- INDUSTRY'S LOWEST DROP OUT VOLTAGE (SEE SPECIFIC DEVICE SPEC)
- QUIESCENT OPERATING CURRENT CONSTANT OVER LOAD RANGE (SEE SPECIFIC DEVICE SPEC)
- MINIMAL OUTPUT CAPACITANCE NECESSARY FOR STABLE OPERATION (0.1µF)
- HIGH LEVELS OF LOAD AND LINE REGULATION MAINTAINED OVER WIDE FREQUENCY RANGE
- ☐ SHORT CIRCUIT PROTECTION
- REVERSE BATTERY PROTECTION WITH NO BATTERY FEATURE
- ☐ FIXED AND ADJUSTABLE OUTPUT VOLTAGES AVAILABLE

## APPLICATIONS

- PORTABLE PHONES
- ☐ PORTABLE PAGERS
- NOTEBOOK COMPUTER POWER SUPPLIES
- BATTERY CHARGERS

#### AVAILABLE OPTIONS PER PART #

Part #	Output Voltage
LX8020-28	2.85V
LX8020-30	3V
LX8020-33	3.3V
LX8020-48	4.8V
LX8020-50	5V
LX8020-00	Adjustable

BERRY	PACKA	GE ORDER INFO	
T <sub>A</sub> (°C)	Initial Tolerance	Plastic T0-92 3-pin	DM Plastic SOIC 8-pin
0 to 70	2%	LX8020-xxCLP	LX8020-xxCDM
	1%	LX8020A-xxCLP	LX8020A-xxCDM
-40 to 85	2%	LX8020-xxILP	LX8020-xxIDM
	1%	LX8020A-xxILP	LX8020A-xxIDM

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX8020-xxDMT) "xx" refers to output voltage, please see table above.

FOR FURTHER INFORMATION CALL (714) 898-8121

# TERRE ATAG THA PRELIMINARY DATA SHEET TO ISVOS STIMINAL BAT

# 

#### THERMAL DATA

#### LP PACKAGE.

EF FACIAGE.	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{\mathrm{JA}}}$	156°C/W
DM PACKAGE:	omit add to signor in
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ.,	165°C/W

Junction Temperature Calculation:  $T_j = T_A + (P_D x \theta_{jA})$ . The  $\theta_{jA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

#### PACKAGE PIN OUTS



LP PACKAGE (Top View)

OUTPUT [	1	8	INPUT
ADJ.º / N.C.	2	7 1	N.C.
GND [	3	6 1	N.C.
N.C.	4	5	SHUTDOWN

DM PACKAGE

(Top View)

\* Pin for Adjustable version only.

# LX8020-xx/8020A-xx

# ULTRA LOW DROP OUT REGULATOR (ULDOTM)

# PRELIMINARY DATA SHEET

RECOMMENDED OPERATING CONDITIONS (Note 4)						
	Symbol	Recommended Operating Conditions				
Parameter	Symoon	Min.	Тур.	Max.	Units	
Input Voltage Range	V <sub>IN</sub> , V <sub>MIN</sub> to V <sub>MAX</sub>			10	V	
Output Current Range	l <sub>out</sub>			200	mA	
Short Circuit Range	I <sub>SC</sub>	2,70	500	W. C. C. C.	mA	
Input Capacitor Range	C <sub>IN</sub>	0.1	North of Thirty	10	μF	
Output Capacitor Range	C <sub>out</sub>	0.1		10	μF	
Junction Temp Range	°C		125	MACT LEW	°C	
Reverse Voltage	V <sub>REV</sub>			-10	V	

## ELECTRICAL CHARACTERISTICS

(Conditions are T = 25°C;  $I_{OUT}$  = 10mA;  $V_{DIFF}$  =  $V_{IN}$ - $V_{OUT}$  = 1V;  $C_{IN}$  = 0.4 $\mu$ F;  $C_{OUT}$  = 0.4 $\mu$ F; and  $V_{ENABLE}$  =  $V_{IN}$ ; unless noted.)

Parameter		Symbol	Test Conditions	LX802	0-xx / 80	20A-xx	Units
		Symoon	Test conditions	Min.	Тур.	Max.	
Output Voltage	LX8020-xx	V <sub>out</sub>	T <sub>A</sub> = 25°C, No Load	-2		+2	%
	LX8020A-xx		T <sub>A</sub> = 25°C, No Load	-1	I PUBLICATION	+1	%
Output Voltage TC			T = 0 to 70°C		100		ppm/°C
Line Regulation	100Hz		$I_{OUT} = 50 \text{mA}, \Delta V_{IN} = 200 \text{mVpp}$	CHILD OF	70	on rega	db
	1KHz		$I_{OUT} = 50 \text{mA}, \Delta V_{IN} = 200 \text{mVpp}$	0.00	65	MOAONS	db
	10KHz		$I_{OUT} = 50 \text{mA}, \Delta V_{IN} = 200 \text{mVpp}$		50		db
	100KHz		$I_{OUT} = 50 \text{mA}, \Delta V_{IN} = 200 \text{mVpp}$		30		db
Load Regulation			$\Delta I_{OUT} = 1$ mA to 200mA		0.5		%
Dropout Voltage		V <sub>DO</sub>	I <sub>OUT</sub> = 200mA		200		mV
			I <sub>OUT</sub> = 50mA		50		mV
Operating or Ground Current	LX8020-50 /A-50				300		μА
	LX8020-48 /A-48				300		μА
	LX8020-33 /A-33				300		μА
	LX8020-30 /A-30			50	210		μA
	LX8020-28 /A-28				210		μΑ
	LX8020-00 /A-00				210		μA
Ground Current Regulation Over	r Input		$\Delta V_{DIFF} = 1V \text{ to } 5V$		40		μA
Ground Current Regulation Ove	r Load		$\Delta I_{OUT} = 1$ mA to 200mA		20		μА
Enable Threshold				1.2		1.8	٧
Off-mode Input Leakage Curren	t		V <sub>ENABLE</sub> = 0V, V <sub>IN</sub> = 10V		1		μА
Reverse Output Leakage Current V <sub>IN</sub> pin = Open			V <sub>ENABLE</sub> = 0V, V <sub>OUT</sub> = Output Voltage		1		μА
	V <sub>IN</sub> pin = Ground		V <sub>ENABLE</sub> = 0V, V <sub>OUT</sub> = Output Voltage		100		μА
Output Noise		en	T <sub>4</sub> = 25°C		TBD		nV/√Hz

# LX8020-xx/8020A-xx

# ULTRA LOW DROP OUT REGULATOR (ULDOTM)

#### PRELIMINARY DATA SHEET

# GRAPH / CURVE INDEX **Characteristic Curves** FIGURE # 1. V<sub>OUT</sub> vs. TEMP 2. V<sub>IN</sub> vs. V<sub>OUT</sub> SHOW START-UP / SHUTDOWN 3. TURN-ON RESPONSE TIME VIN AND VOIT VS. TIME 4. I vs. I 5. I vs. TEMP 6. I VS. VDO 7. V vs. TEMP 8. VDO VS. IOUT 9. I vs. TEMP AND V 10. R<sub>OUT</sub> vs. f 11. RIPPLE REJECTION vs. F AND I 12. LINE TRANSIENT RESPONSE vs. TIME 13. LOAD TRANSIENT RESPONSE vs. TIME, USING DIFFERENT COUT 14. P.-P. NOISE, 0.1Hz to 10Hz 15. BROADBAND NOISE, 1Hz to 1MHz





# LX8383/8383A

7.5A LOW DROPOUT POSITIVE ADJUSTABLE REGULATORS

THE INFINITE POWER OF INNOVATION

PRELIMINARY DATA SHEET

#### DESCRIPTION

The LX8383/8383A are positive adjustable regulators designed to provide 7.5A output current. All internal circuitry is designed to operate down to a 1V input-to-output differential, so the LX8383/8383A can operate with greater efficiency than previously available devices. The dropout voltage for each product is fully specified as a function of load current. Dropout is guaranteed at a maximum of 1.3V for the LX8383A and 1.5V for the LX8383, at maximum output current, decreasing at lower load currents. In addition, on-chip trimming adjusts the reference voltage to 1%.

The LX8383/83A devices are pincompatible with earlier 3-terminal regulators, such as the 117 series products. While a 10µF output capacitor is required on both input and output of these new devices, this capacitor is generally included in most regulator designs.

The LX8383/83A's quiescent current flows into the load, thereby increasing efficiency. This feature contrasts with PNP regulators, where up to 10% of the output current is wasted as quiescent current. The LX8383I/8383AI is specified over the industrial temperature range of -25°C to +125°C and the LX8383C/8383AC is specified over the commercial range of 0°C to +125°C. The LX8383M/8383AM is specified over the military temperature range of -55°C to +125°C.

#### KEY FEATURES

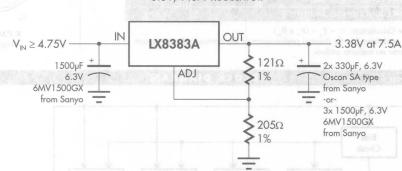
- **THREE-TERMINAL ADJUSTABLE**
- GUARANTEED < 1.3V HEADROOM AT 7.5A (LX8383A)
- GUARANTEED < 1.5V HEADROOM AT 7.5A (LX8383)
- OUTPUT CURRENT OF 7.5A MINIMUM
- 0.015% LINE REGULATION
- 0.15% LOAD REGULATION

#### APPLICATIONS

- PENTIUM® PROCESSOR APPLICATIONS
- HIGH EFFICIENCY LINEAR REGULATORS
- POST REGULATORS FOR SWITCHING POWER SUPPLIES
- BATTERY CHARGERS
- CONSTANT CURRENT REGULATORS

# PRODUCT HIGHLIGHT

3.3V, 7.5A REGULATOR



Application of the LX8383A for the standard voltage (non VRE) Pentium Processor motherboard with less than 130mV dynamic response to a 7.5A load transient.

PACKAGE ORDER INFORMATION						
T <sub>A</sub> (°C)	Dropout Voltage	Plastic TO-220 3-pin	V Plastic TO-247 3-terminal	K TO-3 Metal Can 3-Terminal		
0 - 105	1.5V	LX8383-00CP	LX8383-00CV	_		
0 to 125	1.3V	LX8383A-00CP	LX8383A-00CV			
-25 to 125	1.5V	LX8383-00IP	LX8383-00IV	LX8383-00IK		
-25 to 125	1.3V	LX8383A-00IP	LX8383A-00IV	LX8383A-00IK		
-55 to 125	1.5V	_	_	LX8383-00MK		
33 10 123	1.3V	_	_	LX8383A-00MK		

## ABSOLUTE MAXIMUM RATINGS (Note 1)

Power Dissipation	
	10V
	10V
Operating Junction Temperature	
Hermetic (K - Package)	150°C
Plastic (V - Packages)	
Storage Temperature Range	65°C to 150°C
Lead Temperature (Soldering, 10 seconds)	300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

## THERMAL DATA

#### P PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{_{ m JT}}$	2.7°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{J_A}}$	60°C/W
PACKAGE:	

THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{_{ m JT}}$	1.6°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	35°C/W

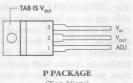
#### K PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{\text{JC}}$	1.6°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{1A}}$	35°C/W

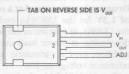
Junction Temperature Calculation:  $T_1 = T_A + (P_D \times \theta_{IA})$ .

The  $\theta_{1}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

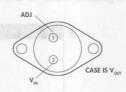
#### **PACKAGE PIN OUTS**



# (Top View)

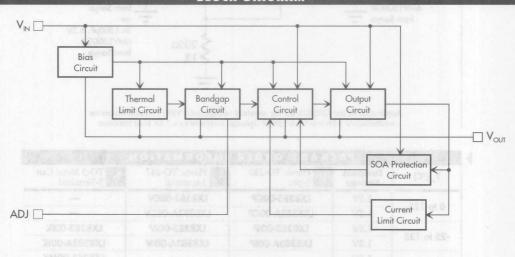


V PACKAGE (Top View)



K PACKAGE (Top View)

#### **BLOCK DIAGRAM**



# 7.5A LOW DROPOUT POSITIVE ADJUSTABLE REGULATORS

# PRELIMINARY DATA SHEET

#### ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the LX8383C/8383AC with 0°C  $\leq$  T<sub>A</sub>  $\leq$  125°C, the LX8383I/8383AI with -25°C  $\leq$  T<sub>A</sub>  $\leq$  125°C, and the LX8383M/8383AM with -55°C  $\leq$  T<sub>A</sub>  $\leq$  125°C; V<sub>IN</sub> - V<sub>O</sub> = 3V; I<sub>O</sub> = 7.5A. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Tost Conditions	LX8	383C/83	1831	Units
Parameter	Symbol	ymbol Test Conditions		Тур.	Max.	Onits
Reference Voltage (Note 4)	V <sub>R</sub>	I <sub>o</sub> = 10mA, T <sub>A</sub> = 25°C	1.238	1.250	1.262	V
	-	$10\text{mA} \le I_{0} \le I_{0 \text{ (MAX)}}, 1.5\text{V} \le (V_{\text{IN}} - V_{0}), V_{\text{IN}} \le 10\text{V}, P \le P_{\text{MAX}}$	1.225	1.250	1.270	٧
Line Regulation (Note 2)	dV <sub>R</sub> (IN)	$1.5V \le (V_{IN} - V_{OUT}), V_{IN} \le 7V$	31	0.015	0.2	%
	r - r1	$1.5V \le (V_{IN} - V_{OUT}), V_{IN} \le 10V$	mosti a a	0.035	0.3	%
Load Regulation (Note 2)	dV <sub>R</sub> (L)	$V_{o} \ge V_{REF}, V_{IN} - V_{o} = 3V, 10mA \le I_{o} \le 7.5A, T_{A} = 25^{\circ}C$	ension i	0.15	0.4	%
	APCIA	$V_{IN} - V_{O} = 3V$ , $10mA \le I_{O} \le 7.5A$	ger eld	0.3	0.5	%
Thermal Regulation (Note 3)	dVo(P)	T <sub>A</sub> = 25°C, 20ms pulse		0.01	0.02	%/W
Ripple Rejection (Note 3)	वेट्यहे हो	$V_0 = 5V, f = 120Hz, C_{OUT} = 100\mu f Tantalum, V_{IN} = 6.5V$	200		17 Land	435
	contentación	$C_{ADJ} = 10 \mu F$ , $T_A = 25 ° C$ , $I_O = 7.5 A$	65	83	a traduct	dB
Adjust Pin Current	I <sub>ADJ</sub>	magazante en estable establishe establishes establishes and	o brancher	55	100	μА
Adjust Pin Current Change (Note 4)	ΔI <sub>ADJ</sub>	$10\text{mA} \le I_{o} \le I_{o \text{ (MAX)}}$ , $1.5\text{V} \le (V_{iN} - V_{o})$ , $V_{iN} \le 10\text{V}$	RESTRICT	0.2	5	μА
Dropout Voltage LX8383A	Δ٧	$\Delta V_{REF} = 1\%$ , $I_{O} = 7.5A$	theorn	estat.	1.3	V
httpsgo-siti oldtivr ografia / LX8383 -	deni le s	$\Delta V_{REF} = 1\%$ , $I_{O} = 7.5A$	F almond	1.2	1.5	V
Minimum Load Current	I <sub>O (MIN)</sub>	V <sub>IN</sub> ≤ 10V los and the language box furthers the line and reserved	avise to	2	10	mA
Maximum Output Current (Note 5)	I <sub>O (MAX)</sub>	$V_{IN} - V_{O} \le 7V$	7.5	9.5	olounees.	A
Temperature Stability (Note 3)	dVo(T)	remed between the output voltage application of the control of	s is on	0.25	sostj <i>e</i> d ja	%
Long Term Stability (Note 3)	dVo(t)	T <sub>A</sub> = 125°C, 1000 hours	unioss.	0.3	1	%
RMS Output Noise (% of Vour ) (Note 3)	V <sub>O RMS</sub>	$T_A = 25^{\circ}C$ , $10Hz \le f \le 10kHz$	a migration	0.003	1 058.58	%

Note 2. Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

Note 3. These parameters, although guaranteed, are not tested in production.

Note 4. See Maximum Output Current Section above.

Note 5. I<sub>O MAXO</sub> is measured under the condition that V<sub>O</sub> is forced below its nominal value by 100mV.



# LX8383/8383A

# 7.5A LOW DROPOUT POSITIVE ADJUSTABLE REGULATORS

# PRELIMINARY DATA SHEET

## APPLICATION NOTES

The LX8383/83A is an easy to use Low-Dropout (LDO) voltage regulator. It has all of the standard self-protection features expected of a voltage regulator: short circuit protection, safe operating area protection and automatic thermal shutdown if the device temperature rises above approximately 165°C.

Use of an output capacitor is REQUIRED with the LX8383/83A. Please see the table below for recommended minimum capacitor values.

The regulator offers a more tightly controlled reference voltage tolerance and superior reference stability when measured against the older pin-compatible regulator types that it replaces.

#### STABILITY

The output capacitor is part of the regulator's frequency compensation system. Many types of capacitors are available, with different capacitance value tolerances, capacitance temperature coefficients, and equivalent series impedances. For all operating conditions, connection of a 220µF aluminum electrolytic capacitor or a  $47\mu\mathrm{F}$  solid tantalum capacitor between the output terminal and ground will guarantee stable operation.

If a bypass capacitor is connected between the output voltage adjust (ADJ) pin and ground, ripple rejection will be improved (please see the section entitled "RIPPLE REJECTION"). When ADJ pin bypassing is used, the required output capacitor value increases. Output capacitor values of 220µF (aluminum) or  $47\mu F$  (tantalum) provide for all cases of bypassing the ADJ pin. If an ADJ pin bypass capacitor is not used, smaller output capacitor values are adequate. The table below shows recommended minimum capacitance values for stable operation.

#### RECOMMENDED CAPACITOR VALUES

INPUT	OUTPUT	ADJ
10µF	15µF Tantalum, 100µF Aluminum	None
10µF	47μF Tantalum, 220μF Aluminum	15µF

In order to ensure good transient response from the power supply system under rapidly changing current load conditions, designers generally use several output capacitors connected in parallel. Such an arrangement serves to minimize the effects of the parasitic resistance (ESR) and inductance (ESL) that are present in all capacitors. Cost-effective solutions that sufficiently limit ESR and ESL effects generally result in total capacitance values in the range of hundreds to thousands of microfarads, which is more than adequate to meet regulator output capacitor specifications. Output capacitance values may be increased without limit.

The circuit shown in Figure 1 can be used to observe the transient response characteristics of the regulator in a power system under changing loads. The effects of different capacitor types and values on transient response parameters, such as overshoot and undershoot, can be quickly compared in order to develop an optimum solution.

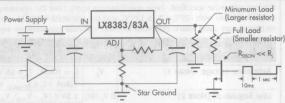


FIGURE 1 — DYNAMIC INPUT and OUTPUT TEST

#### OVERLOAD RECOVERY

Like almost all IC power regulators, the LX8383/83A is equipped with Safe Operating Area (SOA) protection. The SOA circuit limits the regulator's maximum output current to progressively lower values as the input-to-output voltage difference increases. By limiting the maximum output current, the SOA circuit keeps the amount of power that is dissipated in the regulator itself within safe limits for all values of input-to-output voltage within the operating range of the regulator. The LX8383/83A SOA protection system is designed to be able to supply some output current for all values of input-to-output voltage, up to the device breakdown voltage.

Under some conditions, a correctly operating SOA circuit may prevent a power supply system from returning to regulated operation after removal of an intermittent short circuit at the output of the regulator. This is a normal mode of operation which can be seen in most similar products, including older devices such as 7800 series regulators. It is most likely to occur when the power system input voltage is relatively high and the load impedance is relatively low.

When the power system is started "cold", both the input and output voltages are very close to zero. The output voltage closely follows the rising input voltage, and the input-to-output voltage difference is small. The SOA circuit therefore permits the regulator to supply large amounts of current as needed to develop the designed voltage level at the regulator output. Now consider the case where the regulator is supplying regulated voltage to a resistive load under steady state conditions. A moderate input-to-output voltage appears across the regulator but the voltage difference is small enough that the SOA circuitry allows sufficient current to flow through the regulator to develop the designed output voltage across the load resistance. If the output resistor is short-circuited to ground, the input-to-output voltage difference across the regulator suddenly becomes larger by the amount of voltage that had appeared across the load resistor. The SOA circuit reads the increased input-tooutput voltage, and cuts back the amount of current that it will permit the regulator to supply to its output terminal. When the short circuit across the output resistor is removed, all the regulator output current will again flow through the output resistor. The maximum current that the regulator can supply to the resistor will be limited by the SOA circuit, based on the large input-to-output voltage across the regulator at the time the short circuit is removed from the output. If this limited current is not sufficient to develop the designed



# 7.5A LOW DROPOUT POSITIVE ADJUSTABLE REGULATORS

#### PRELIMINARY DATA SHEET

#### APPLICATION NOTES

#### **OVERLOAD RECOVERY** (continued)

voltage across the output resistor, the voltage will stabilize at some lower value, and will *never* reach the designed value. Under these circumstances, it may be necessary to cycle the input voltage down to zero in order to make the regulator output voltage return to regulation.

#### RIPPLE REJECTION

Ripple rejection can be improved by connecting a capacitor between the ADJ pin and ground. The value of the capacitor should be chosen so that the impedance of the capacitor is equal in magnitude to the resistance of R1 *at the ripple frequency*. The capacitor value can be determined by using this equation:

$$C = 1 / (6.28 * F_n * R1)$$
 transports achoosil and

where: C ≡ the value of the capacitor in Farads; select an equal or larger standard value.

 $F_R$  = the ripple frequency in Hz R1 = the value of resistor R1 in ohms

At a ripple frequency of 120Hz, with R1 =  $100\Omega$ 

$$C = 1 / (6.28 * 120 Hz * 100 \Omega) = 13.3 \mu F$$

The closest equal or larger standard value should be used, in this case, 15µF.

When an ADJ pin bypass capacitor is used, output ripple amplitude will be essentially independent of the output voltage. If an ADJ pin bypass capacitor is not used, output ripple will be proportional to the ratio of the output voltage to the reference voltage:

$$M = V_{out}/V_{out}$$

where:  $M \equiv a$  multiplier for the ripple seen when the ADJ pin is optimally bypassed.  $V_{\text{NEF}} = 1.25 \text{V}$ .

For example, if  $V_{OUT} = 2.5V$  the output ripple will be:

$$M = 2.5V/1.25V = 2$$

Output ripple will be twice as bad as it would be if the ADJ pin were to be bypassed to ground with a properly selected capacitor.

#### **OUTPUT VOLTAGE**

The LX8383/83A develops a 1.25V reference voltage between the output and the adjust terminal (See Figure 2). By placing a resistor, R1, between these two terminals, a constant current is caused to flow through R1 and down through R2 to set the overall output voltage. Normally this current is the specified minimum load current of 10mA. Because  $I_{\rm ADJ}$  is very small and constant when compared with the current through R1, it represents a small error and can usually be ignored.

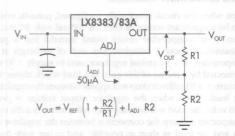


FIGURE 2 — BASIC ADJUSTABLE REGULATOR

#### LOAD REGULATION

Because the LX8383/83A is a three-terminal device, it is not possible to provide true remote load sensing. Load regulation will be limited by the resistance of the wire connecting the regulator to the load. The data sheet specification for load regulation is measured at the bottom of the package. Negative side sensing is a true Kelvin connection, with the bottom of the output divider returned to the negative side of the load. Although it may not be immediately obvious, best load regulation is obtained when the top of the resistor divider, (R1), is connected *directly* to the case of the regulator, *not to the load*. This is illustrated in Figure 3. If R1 were connected to the load, the effective resistance between the regulator and the load would be:

$$R_{peff} = R_p * \left(\frac{R2+R1}{R1}\right)$$

where:  $R_p \equiv Actual parasitic line resistance.$ 

When the circuit is connected as shown in Figure 3, the parasitic resistance appears as its actual value, rather than the higher  $R_{\rm peff}$ .

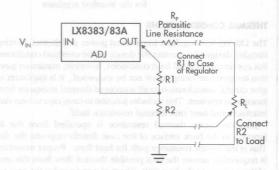


FIGURE 3 — CONNECTIONS FOR BEST LOAD REGULATION

#### **APPLICATION NOTES**

#### LOAD REGULATION (continued)

Even when the circuit is optimally configured, parasitic resistance can be a significant source of error. A 100 mil wide PC trace built from 1 oz. copper-clad circuit board material has a parasitic resistance of about 5 milliohms per inch of its length at room temperature. If a 3-terminal regulator used to supply 2.50 volts is connected by 2 inches of this trace to a load which draws 5 amps of current, a 50 millivolt drop will appear between the regulator and the load. Even when the regulator output voltage is precisely 2.50 volts, the load will only see 2.45 volts, which is a 2% error. It is important to keep the connection between the regulator output pin and the load as short as possible, and to use wide traces or heavy-gauge wire.

The minimum specified output capacitance for the regulator should be located near the reglator package. If several capacitors are used in parallel to construct the power system output capacitance, any capacitors beyond the minimum needed to meet the specified requirements of the regulator should be located near the sections of the load that require rapidly-changing amounts of current. Placing capacitors near the sources of load transients will help ensure that power system transient response is not impaired by the effects of trace impedance.

To maintain good load regulation, wide traces should be used on the input side of the regulator, especially between the input capacitors and the regulator. Input capacitor ESR must be small enough that the voltage at the input pin does not drop below  $V_{_{\rm IN\, (MIN)}}$ during transients.

$$V_{IN (MIN)} = V_{OUT} + V_{DROPOUT (MAX)}$$

where:  $V_{\text{IN (MIN)}}$  = the lowest allowable instantaneous voltage at the input pin.

≡ the designed output voltage for the power supply system.  $V_{DROPOUT (MAX)} \equiv$  the specified dropout voltage

for the installed regulator.

#### THERMAL CONSIDERATIONS

The LX8383/83A regulator has internal power and thermal limiting circuitry designed to protect the device under overload conditions. For continuous normal load conditions, however, maximum junction temperature ratings must not be exceeded. It is important to give careful consideration to all sources of thermal resistance from junction to ambient. This includes junction to case, case to heat sink interface, and heat sink thermal resistance itself.

Junction-to-case thermal resistance is specified from the IC junction to the back surface of the case directly opposite the die. This is the lowest resistance path for heat flow. Proper mounting is required to ensure the best possible thermal flow from this area of the package to the heat sink. Thermal compound at the case-toheat-sink interface is strongly recommended. If the case of the device must be electrically isolated, a thermally conductive spacer

can be used, as long as its added contribution to thermal resistance is considered. Note that the case of all devices in this series is electrically connected to the output.

#### Example

Given:  $V_{IN} = 5V$   $V_{O} = 2.8V$ ,  $I_{O} = 5.0A$ Ambient Temp.,  $T_A = 50$ °C  $R_{\text{err}} = 2.7^{\circ}\text{C/W}$  for TO-220 300 ft/min airflow available

Find: Proper Heat Sink to keep IC's junction temperature below 125°C.\*\*

Solution: The junction temperature is:

$$T_{I} = P_{D} (R_{\theta IT} + R_{\theta CS} + R_{\theta SA}) + T_{A}$$

where:  $P_D \equiv Dissipated power$ .

 $R_{\theta TT} \equiv$  Thermal resistance from the junction to the mounting tab of the package.

 $R_{\theta CS} \equiv$  Thermal resistance through the interface between the IC and the surface on which it is mounted. (1.0°C/W at 6 in-lbs mounting screw torque.)

 $R_{\theta SA} \equiv$  Thermal resistance from the mounting surface to ambient (thermal resistance of the heat sink).

 $T_s \equiv \text{Heat sink temperature.}$ 

$$T_J \underbrace{T_C}_{R_{0T}} \underbrace{T_S}_{R_{0SA}} \underbrace{T_A}_{R_{SA}}$$

First, find the maximum allowable thermal resistance of the

$$R_{\text{BSA}} = \frac{T_{J} - T_{A}}{P_{D}} - (R_{\text{BJT}} + R_{\text{BCS}})$$

$$P_{D} = (V_{\text{INOMAX}} - V_{O}) I_{O} = (5.0V - 2.8V) * 5.0A$$

$$= 11.0W$$

$$R_{\text{BSA}} = \frac{125^{\circ}\text{C} - 50^{\circ}\text{C}}{(5.0V - 2.8V) * 5.0A} - (2.7^{\circ}\text{C/W} + 1.0^{\circ}\text{C/W})$$

$$= 3.1^{\circ}\text{C/W}$$

Next, select a suitable heat sink. The selected heat sink must have  $R_{_{BSA}} \le 3.1$ °C/W. Thermalloy heatsink 6296B has  $R_{_{BSA}} = 3.0$ °C/W with 300ft/min air flow.

Finally, verify that junction temperature remains within specification using the selected heat sink:

$$T_{T} = 11W (2.7^{\circ}C/W + 1.0^{\circ}C/W + 3.0^{\circ}C/W) + 50^{\circ}C = 124^{\circ}C$$

Although the device can operate up to 150°C junction, it is recommended for long term reliability to keep the junction temperature below 125°C whenever possible.

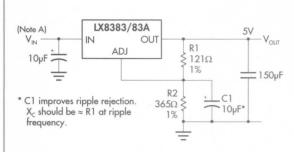


# LX8383/8383A

# 7.5A LOW DROPOUT POSITIVE ADJUSTABLE REGULATORS

## PRELIMINARY DATA SHEET

## TYPICAL APPLICATIONS



V<sub>IN</sub> OUT R1 121Ω + C1\* 100μF

\* Needed if device is far from filter capacitors.

\*\* 
$$V_{OUT} = 1.25V \left(1 + \frac{R2}{R1}\right)$$

FIGURE 4 — IMPROVING RIPPLE REJECTION

FIGURE 5 — 1.2V - 8V ADJUSTABLE REGULATOR

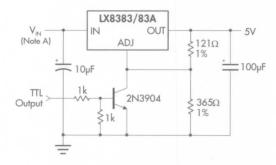


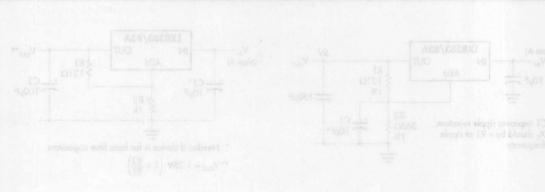
FIGURE 6 — 5V REGULATOR WITH SHUTDOWN

Note A:  $V_{IN (MIN)} = (Intended V_{OUT}) + (V_{DROPOUT (MAX)})$ 

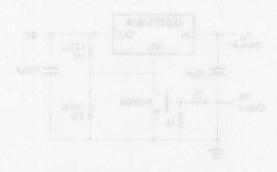


# Notes

# PRILIMINARY DATA SHIFT



SURE 4 — INFROVING RIPH I RESCTION NOUSE 5 — 1 2V - 3V ADJUSTABLE REGULAT



SOURCE & - SVALGULATER WITH SHIFTDOWN

burnings an content builtings I heat to superior





# LX8384/8384A

# 5A LOW DROPOUT POSITIVE ADJUSTABLE REGULATORS

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

The LX8384/84A are positive adjustable regulators designed to provide 5A output current. These regulators vield higher efficiency than currently available devices with all internal circuitry designed to operate down to a 1V input-to-output differential. In each of these products, the dropout voltage is fully specified as a function of load current. Dropout is guaranteed at a maximum of 1.3V (8384A) and 1.5V (8384) at maximum output current, decreasing at lower load currents. In addition, on-chip trimming adjusts the reference voltage to 1% maximum at room temperature and 1.5% maximum over the 0 to 125°C range for the LX8384A, making this ideal for the Pentium P54C-VRE specification.

The LX8384/84A devices are pincompatible with earlier 3-terminal regulators, such as the 117 series products. While a 10µF output capacitor is required on both input and output of these new devices, this capacitor is generally included in most regulator designs.

The LX8384/84A quiescent current flows into the load, thereby increasing efficiency. This feature constrasts with PNP regulators where up to 10% of the output current is wasted as quiescent current. The LX8384I is specified over the industrial temperature range of -25°C to 125°C, and the LX8384C/84AC is specified over the commercial range of 0°C to 125°C.

#### **KEY FEATURES**

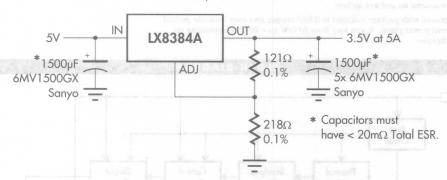
- THREE-TERMINAL ADJUSTABLE
- GUARANTEED < 1.3V HEADROOM AT 5A (LX8384A)
- GUARANTEED 1.5% MAX. REFERENCE (LX8384A)
- OUTPUT CURRENT OF 5A MINIMUM
- 0.015% LINE REGULATION
- 0.15% LOAD REGULATION

#### APPLICATIONS

- PENTIUM® PROCESSOR VRE APPLICATIONS
- HIGH EFFICIENCY LINEAR REGULATORS
- POST REGULATORS FOR SWITCHING POWER SUPPLIES
- BATTERY CHARGERS
- CONSTANT CURRENT REGULATORS

#### PRODUCT HIGHLIGHT

3.5V, 5A REGULATOR



An application of the LX8384A for the Pentium P54C processors meeting VRE specification.

		PACKA	GE ORDI	R INFORMAT	ION
	T <sub>A</sub> (°C)	Max. Ref. Accuracy	Max. Dropout Voltage	P Plastic TO-220 3-pin	DD Plastic TO-263 3-pin
1	0 1- 105	2%	1.5V	LX8384-00CP	LX8384-00CDD
	0 to 125	1.5%	1.3V	LX8384A-00CP	LX8384A-00CDD
	-25 to 125	2%	1.5V	LX8384-00IP	LX8384-00IDD

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX8384A-00CDDT)

#### ABSOLUTE MAXIMUM RATINGS (Note 1)

Power Dissipation	Internally Limited
	10V
Operating Junction Temperature	
Hermetic (K - Package)	150°C
Plastic (DD - Package)	150°C
Storage Temperature Range	65°C to 150°C
Lead Temperature (Soldering, 10 seconds)	300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

#### THERMAL DATA

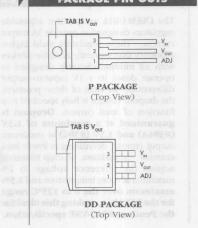
#### P PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{ m JT}$	2.7°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{\mathrm{JA}}}$	60°C/W
DD PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{_{\mathrm{JT}}}$	2.7°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, 0	60°C/W*

Junction Temperature Calculation:  $T_J$  =  $T_A$  + ( $P_D$  x  $\theta_{JA}$ ). The  $\theta_{JA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

\*  $\theta_{ts}$  can be improved with package soldered to  $0.5 \text{IN}^2$  copper area over backside ground plane or internal power plane.  $\theta_{IA}$  can vary from 20°C/W to > 40°C/W depending on mounting technique.

#### **PACKAGE PIN OUTS**



# **BLOCK DIAGRAM** VIN -Bias Circuit Thermal Bandgap Output Control Limit Circuit Circuit Circuit Circuit -U Vout SOA Protection Circuit Current ADJ \_\_ Limit Circuit

# 5A LOW DROPOUT POSITIVE ADJUSTABLE REGULATORS

#### PRODUCTION DATA SHEET

#### **ELECTRICAL CHARACTERISTICS**

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the LX8384C/8384AC with  $0^{\circ}$ C  $\leq$   $T_{A}$   $\leq$   $125^{\circ}$ C, and the LX8384I with -25°C  $\leq$   $T_A \leq$  125°C,  $V_{IN}$  -  $V_O = 3V$ ;  $I_O = 5A$ . Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Baramatar	Symbol	ol Test Conditions		LX8384C/84AC/84I		
Parameter	Symbol	lest conditions	Min. Typ.	Max.	Units	
Reference Voltage	V <sub>R</sub>	I <sub>o</sub> = 10mA, T <sub>A</sub> = 25°C	1.238	1.250	1.262	V
(Note 4)		$10\text{mA} \le I_0 \le 5\text{A}, 1.5\text{V} \le (V_{\text{IN}} - V_0), V_{\text{IN}} \le 10\text{V}, P \le P_{\text{MAX}}$	1.225	1.250	1.270	٧
Line Regulation (Note 2)	dV <sub>R</sub> (IN)	$1.3V \le (V_{IN} - V_{OUT}), V_{IN} \le 7V, I_{O} = 10 \text{mA}$		0.015	0.2	%
	0 - 11	$1.3V \le (V_{IN} - V_{OUT}), V_{IN} \le 10V, I_{O} = 10mA$	NORI ERON	0.035	0.3	%
Load Regulation (Note 2)	dV <sub>R</sub> (L)	$V_{o} \ge V_{REF}$ , $V_{IN} - V_{o} = 3V$ , $10mA \le I_{o} \le 5A$ , $T_{A} = 25$ °C	Inglet k	0.15	0.5	%
Thermal Regulation (Note 3)	dVo(P)	T <sub>A</sub> = 25°C, 20ms pulse	321 210	0.01	0.02	%/W
Ripple Rejection (Note 3)	nowing f	$V_{o} = 5V, f = 120Hz, C_{out} = 100\mu f Tantalum, V_{IN} = 6.5V$				Control of
	LanA.go	$C_{ADJ} = 10 \mu F$ , $T_A = 25 °C$ , $I_O = 5A$	65	83	VAME	dB
Adjust Pin Current	I <sub>ADJ</sub>		20	55	100	μΑ
Adjust Pin Current Change (Note 4)	ΔI <sub>ADJ</sub>	$10\text{mA} \le I_0 \le I_{O(MAX)}$ , $1.3V \le (V_{IN} - V_0)$ , $V_{IN} \le 10V$	The said of	0.2	5	μА
Dropout Voltage LX8384A	Δ٧	$\Delta V_{REF} = 1\%$ , $I_O = 5A$	Length	1.1	1.3	٧
LX8384	ly alderfr	$\Delta V_{REF} = 1\%$ , $I_{O} = 5A$	heggs	1.2	1.5	V
Minimum Load Current	I <sub>O (MIN)</sub>	V <sub>IN</sub> ≤ 10V	F plustre	2	10	mA
Maximum Output Current (Note 5)	I <sub>O (MAX)</sub>	V <sub>IN</sub> - V <sub>O</sub> ≤ 7V	5	6	where the	Α
	din sign of	$V_{IN} - V_{O} \le 10V$	3	4	Mittersuig	A
Temperature Stability (Note 3)	dVo(T)	r ivipiro-essagni oggas sugma om nacorted haraan	no ai no	0.25	a byne	%
Long Term Stability (Note 3)	dVo(t)	T <sub>A</sub> = 125°C, 1000 hours	SECTION.	0.3	1	%
RMS Output Noise (% of Vout) (Note 3)	V <sub>O RMS</sub>	$T_A = 25$ °C, $10$ Hz $\leq f \leq 10$ kHz	in country	0.003	1 00% See	%

Note 2. Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

Note 3. These parameters, although guaranteed, are not tested in production.

Note 4. See Maximum Output Current Section above.

Note 5. I<sub>O MAN</sub> is measured under the condition that V<sub>O</sub> is forced below its nominal value by 100mV.



# 5A LOW DROPOUT POSITIVE ADJUSTABLE REGULATORS

# PRODUCTION DATA SHEET

### APPLICATION NOTES

The LX8384/84A is an easy to use Low-Dropout (LDO) voltage regulator. It has all of the standard self-protection features expected of a voltage regulator: short circuit protection, safe operating area protection and automatic thermal shutdown if the device temperature rises above approximately 165°C.

Use of an output capacitor is REQUIRED with the LX8384/84A. Please see the table below for recommended minimum capacitor

The regulator offers a more tightly controlled reference voltage tolerance and superior reference stability when measured against the older pin-compatible regulator types that it replaces.

#### STABILITY

The output capacitor is part of the regulator's frequency compensation system. Many types of capacitors are available, with different capacitance value tolerances, capacitance temperature coefficients, and equivalent series impedances. For all operating conditions, connection of a 220µF aluminum electrolytic capacitor or a  $47\mu F$  solid tantalum capacitor between the output terminal and ground will guarantee stable operation.

If a bypass capacitor is connected between the output voltage adjust (ADJ) pin and ground, ripple rejection will be improved (please see the section entitled "RIPPLE REJECTION"). When ADJ pin bypassing is used, the required output capacitor value increases. Output capacitor values of 220µF (aluminum) or  $47\mu F$  (tantalum) provide for all cases of bypassing the ADJ pin. If an ADJ pin bypass capacitor is not used, smaller output capacitor values are adequate. The table below shows recommended minimum capacitance values for stable operation.

#### RECOMMENDED CAPACITOR VALUES

INPUT	OUTPUT	ADJ
10µF	15µF Tantalum, 100µF Aluminum	None
10µF	47µF Tantalum, 220µF Aluminum	15pF

In order to ensure good transient response from the power supply system under rapidly changing current load conditions, designers generally use several output capacitors connected in parallel. Such an arrangement serves to minimize the effects of the parasitic resistance (ESR) and inductance (ESL) that are present in all capacitors. Cost-effective solutions that sufficiently limit ESR and ESL effects generally result in total capacitance values in the range of hundreds to thousands of microfarads, which is more than adequate to meet regulator output capacitor specifications. Output capacitance values may be increased without limit.

The circuit shown in Figure 1 can be used to observe the transient response characteristics of the regulator in a power system under changing loads. The effects of different capacitor types and values on transient response parameters, such as overshoot and undershoot, can be quickly compared in order to develop an optimum solution.

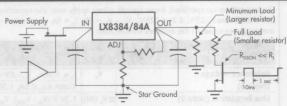


FIGURE 1 — DYNAMIC INPUT and OUTPUT TEST

#### OVERLOAD RECOVERY

Like almost all IC power regulators, the LX8384/84A is equipped with Safe Operating Area (SOA) protection. The SOA circuit limits the regulator's maximum output current to progressively lower values as the input-to-output voltage difference increases. By limiting the maximum output current, the SOA circuit keeps the amount of power that is dissipated in the regulator itself within safe limits for all values of input-to-output voltage within the operating range of the regulator. The LX8384/84A SOA protection system is designed to be able to supply some output current for all values of input-to-output voltage, up to the device breakdown voltage.

Under some conditions, a correctly operating SOA circuit may prevent a power supply system from returning to regulated operation after removal of an intermittent short circuit at the output of the regulator. This is a normal mode of operation which can be seen in most similar products, including older devices such as 7800 series regulators. It is most likely to occur when the power system input voltage is relatively high and the load impedance is relatively low

When the power system is started "cold", both the input and output voltages are very close to zero. The output voltage closely follows the rising input voltage, and the input-to-output voltage difference is small. The SOA circuit therefore permits the regulator to supply large amounts of current as needed to develop the designed voltage level at the regulator output. Now consider the case where the regulator is supplying regulated voltage to a resistive load under steady state conditions. A moderate input-to-output voltage appears across the regulator but the voltage difference is small enough that the SOA circuitry allows sufficient current to flow through the regulator to develop the designed output voltage across the load resistance. If the output resistor is short-circuited to ground, the input-to-output voltage difference across the regulator suddenly becomes larger by the amount of voltage that had appeared across the load resistor. The SOA circuit reads the increased input-tooutput voltage, and cuts back the amount of current that it will permit the regulator to supply to its output terminal. When the short circuit across the output resistor is removed, all the regulator output current will again flow through the output resistor. The maximum current that the regulator can supply to the resistor will be limited by the SOA circuit, based on the large input-to-output voltage across the regulator at the time the short circuit is removed from the output. If this limited current is not sufficient to develop the designed



# 5A Low Dropout Positive Adjustable Regulators

#### PRODUCTION DATA SHEET

#### APPLICATION NOTES

#### **OVERLOAD RECOVERY** (continued)

voltage across the output resistor, the voltage will stabilize at some lower value, and will *never* reach the designed value. Under these circumstances, it may be necessary to cycle the input voltage down to zero in order to make the regulator output voltage return to regulation.

#### RIPPLE REJECTION

Ripple rejection can be improved by connecting a capacitor between the ADJ pin and ground. The value of the capacitor should be chosen so that the impedance of the capacitor is equal in magnitude to the resistance of R1 *at the ripple frequency*. The capacitor value can be determined by using this equation:

$$C = 1 / (6.28 * F_p * R1)$$

where: C ≡ the value of the capacitor in Farads; select an equal or larger standard value.

 $F_R \equiv$  the ripple frequency in Hz R1  $\equiv$  the value of resistor R1 in ohms

At a ripple frequency of 120Hz, with R1 =  $100\Omega$ :

$$C = 1 / (6.28 * 120 Hz * 100\Omega) = 13.3 uF$$

The closest equal or larger standard value should be used, in this case,  $15\mu F$ .

When an ADJ pin bypass capacitor is used, output ripple amplitude will be essentially independent of the output voltage. If an ADJ pin bypass capacitor is not used, output ripple will be proportional to the ratio of the output voltage to the reference voltage:

$$M = V_{OUT}/V_{REF}$$

where:  $M \equiv a$  multiplier for the ripple seen when the ADJ pin is optimally bypassed.  $V_{REF} = 1.25V$ .

For example, if  $V_{OUT} = 2.5V$  the output ripple will be:

$$M = 2.5V/1.25V = 2$$

Output ripple will be twice as bad as it would be if the ADJ pin were to be bypassed to ground with a properly selected capacitor.

#### **OUTPUT VOLTAGE**

The LX8384/84A develops a 1.25V reference voltage between the output and the adjust terminal (See Figure 2). By placing a resistor, R1, between these two terminals, a constant current is caused to flow through R1 and down through R2 to set the overall output voltage. Normally this current is the specified minimum load current of 10mA. Because  $I_{\rm ADJ}$  is very small and constant when compared with the current through R1, it represents a small error and can usually be ignored.

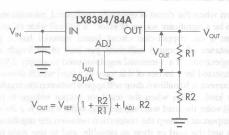


FIGURE 2 — BASIC ADJUSTABLE REGULATOR

#### LOAD REGULATION

Because the LX8384/84A is a three-terminal device, it is not possible to provide true remote load sensing. Load regulation will be limited by the resistance of the wire connecting the regulator to the load. The data sheet specification for load regulation is measured at the bottom of the package. Negative side sensing is a true Kelvin connection, with the bottom of the output divider returned to the negative side of the load. Although it may not be immediately obvious, best load regulation is obtained when the top of the resistor divider, (R1), is connected *directly* to the case of the regulator, *not to the load*. This is illustrated in Figure 3. If R1 were connected to the load, the effective resistance between the regulator and the load would be:

$$R_{peff} = R_p * \left(\frac{R2+R1}{R1}\right)$$

where:  $R_p \equiv Actual$  parasitic line resistance.

When the circuit is connected as shown in Figure 3, the parasitic resistance appears as its actual value, rather than the higher  $R_{\rm peff}$ .

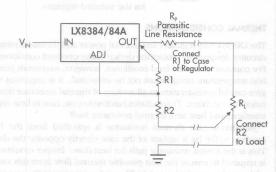


FIGURE 3 — CONNECTIONS FOR BEST LOAD REGULATION

#### APPLICATION NOTES

#### LOAD REGULATION (continued)

Even when the circuit is optimally configured, parasitic resistance can be a significant source of error. A 100 mil wide PC trace built from 1 oz. copper-clad circuit board material has a parasitic resistance of about 5 milliohms per inch of its length at room temperature. If a 3-terminal regulator used to supply 2.50 volts is connected by 2 inches of this trace to a load which draws 5 amps of current, a 50 millivolt drop will appear between the regulator and the load. Even when the regulator output voltage is precisely 2.50 volts, the load will only see 2.45 volts, which is a 2% error. It is important to keep the connection between the regulator output pin and the load as short as possible, and to use wide traces or heavy-gauge wire.

The minimum specified output capacitance for the regulator should be located near the reglator package. If several capacitors are used in parallel to construct the power system output capacitance, any capacitors beyond the minimum needed to meet the specified requirements of the regulator should be located near the sections of the load that require rapidly-changing amounts of current. Placing capacitors near the sources of load transients will help ensure that power system transient response is not impaired by the effects of trace impedance.

To maintain good load regulation, wide traces should be used on the input side of the regulator, especially between the input capacitors and the regulator. Input capacitor ESR must be small enough that the voltage at the input pin does not drop below  $V_{\tiny \mbox{\footnotesize{IN}}\mbox{\footnotesize{OdINO}}}$  during transients.

$$V_{IN (MIN)} = V_{OUT} + V_{DROPOUT (MAX)}$$

 $\label{eq:Windows} \mbox{where:} \quad \mbox{$V_{\rm IN\ (MIN)}$} \qquad \equiv \mbox{the lowest allowable instantaneous} \\ \mbox{voltage at the input pin.}$ 

V<sub>OUT</sub> ≡ the designed output voltage for the power supply system.

 $V_{DROPOUT (MAX)} \equiv$  the specified dropout voltage for the installed regulator.

#### THERMAL CONSIDERATIONS

The LX8384/84A regulator has internal power and thermal limiting circuitry designed to protect the device under overload conditions. For continuous normal load conditions, however, maximum junction temperature ratings must not be exceeded. It is important to give careful consideration to all sources of thermal resistance from junction to ambient. This includes junction to case, case to heat sink interface, and heat sink thermal resistance itself.

Junction-to-case thermal resistance is specified from the IC junction to the back surface of the case directly opposite the die. This is the lowest resistance path for heat flow. Proper mounting is required to ensure the best possible thermal flow from this area of the package to the heat sink. Thermal compound at the case-to-heat-sink interface is strongly recommended. If the case of the device must be electrically isolated, a thermally conductive spacer

can be used, as long as its added contribution to thermal resistance is considered. Note that the case of all devices in this series is electrically connected to the output.

#### Example

Given: 
$$V_{IN} = 5V$$
  
 $V_{O} = 2.8V$ ,  $I_{O} = 5.0A$   
Ambient Temp.,  $T_{A} = 50^{\circ}C$   
 $R_{BT} = 2.7^{\circ}C/W$  for TO-220  
300 ft/min airflow available

Find: Proper Heat Sink to keep IC's junction temperature below 125°C.\*\*

Solution: The junction temperature is:

$$T_{J} = P_{D} (R_{\theta JT} + R_{\theta CS} + R_{\theta SA}) + T_{A}$$

where:  $P_D \equiv Dissipated power$ .

 $R_{\theta JT} \equiv$  Thermal resistance from the junction to the mounting tab of the package.

 $R_{BCS} \equiv$  Thermal resistance through the interface between the IC and the surface on which it is mounted. (1.0°C/W at 6 in-lbs mounting screw torque.)

R<sub>0SA</sub> = Thermal resistance from the mounting surface to ambient (thermal resistance of the heat sink).

 $T_s \equiv \text{Heat sink temperature.}$ 

First, find the maximum allowable thermal resistance of the heat sink:

$$\begin{split} R_{\text{BSA}} &= \frac{T_{\text{J}} - T_{\text{A}}}{P_{\text{D}}} - (R_{\text{BJT}} + R_{\text{BCS}}) \\ P_{\text{D}} &= (V_{\text{INMANO}} - V_{\text{O}}) I_{\text{O}} = (5.0V - 2.8V) * 5.0A \\ &= 11.0W \\ R_{\text{BSA}} &= \frac{125^{\circ}\text{C} - 50^{\circ}\text{C}}{(5.0V - 2.8V) * 5.0A} - (2.7^{\circ}\text{C/W} + 1.0^{\circ}\text{C/W}) \\ &= 3.1^{\circ}\text{C/W} \end{split}$$

Next, select a suitable heat sink. The selected heat sink must have  $R_{BSA} \leq 3.1^{\circ} \text{C/W}$ . Thermalloy heatsink 6296B has  $R_{BSA} = 3.0^{\circ} \text{C/W}$  with 300ft/min air flow.

Finally, verify that junction temperature remains within specification using the selected heat sink:

$$T_1 = 11W (2.7^{\circ}C/W + 1.0^{\circ}C/W + 3.0^{\circ}C/W) + 50^{\circ}C = 124^{\circ}C$$

\*\* Although the device can operate up to 150°C junction, it is recommended for long term reliability to keep the junction temperature below 125°C whenever possible.



# LX8384/8384A

# 5A LOW DROPOUT POSITIVE ADJUSTABLE REGULATORS

## PRODUCTION DATA SHEET

# TYPICAL APPLICATIONS

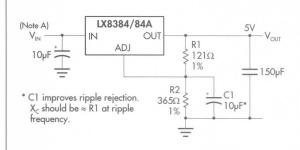
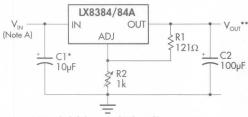


FIGURE 4 — IMPROVING RIPPLE REJECTION



\* Needed if device is far from filter capacitors.

\*\* 
$$V_{OUT} = 1.25V \left(1 + \frac{R2}{R1}\right)$$

FIGURE 5 — 1.2V - 8V ADJUSTABLE REGULATOR

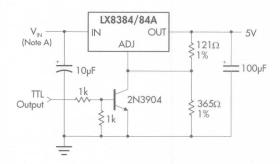


FIGURE 6 — 5V REGULATOR WITH SHUTDOWN

Note A:  $V_{IN (MIN)} = (Intended V_{OUT}) + (V_{DROPOUT (MAX)})$ 



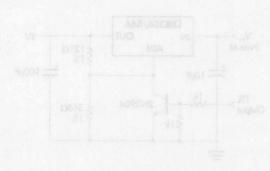
# Notes

TROBUCTION DATA SHEET

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MELINE 5 - 1.9V- BY ADJUSTABLE REGULATOR

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Note  $A: V_{n, \text{term}} = (\text{intended } V_{\text{per}}) + (V_{\text{inducer} \, \text{order}})$ 

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LX8385

# 3A LOW DROPOUT POSITIVE ADJUSTABLE REGULATOR

THE INFINITE POWER OF INNOVATION PRODUCTION DATA SHEET

#### DESCRIPTION

The LX8385 is a positive adjustable regulator designed to provide 3A output current. This regulator yields higher efficiency than currently available devices with all internal circuitry designed to operate down to a 1V input to output differential. In this product, the dropout voltage is fully specified as a function of load current. Dropout is guaranteed at a maximum of 1.5V at maximum output current, decreasing at lower load currents. On-chip trimming adjusts the reference voltage to 1%.

The LX8385 device is pin compatible with

earlier 3 terminal regulators, such as 117 series products. While a 10µF output capacitor is required on both input and output of these new devices, this is generally included in most regulator

The LX8385 quiescent current flows into the load, increasing efficiency. This feature contrasts with PNP regulator designs, where up to 10% of the output current is wasted as quiescent current. The LX8385I for -25°C to +125°C and the LX8385C for 0°C to +125°C.

#### **KEY FEATURES**

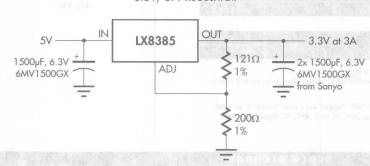
- THREE-TERMINAL ADJUSTABLE
- GUARANTEED < 1.5V HEADROOM AT 3A
- OUTPUT CURRENT OF 3A MINIMUM
- 0.015% LINE REGULATION
- 0.1% LOAD REGULATION

#### APPLICATIONS

- HIGH EFFICIENCY LINEAR REGULATORS
- POST REGULATORS FOR SWITCHING POWER SUPPLIES
- BATTERY CHARGERS
- CONSTANT CURRENT REGULATORS

# PRODUCT HIGHLIGHT

3.3V, 3A REGULATOR



# PACKAGE ORDER INFORMATIONS

T <sub>A</sub> (°C)	P Plastic TO-220 3-pin	DD Plastic TO-263 3-pin
0 to 125	LX8385-00CP	LX8385-00CDD
-25 to 125	LX8385-00IP	LX8385-00IDD

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX8385-00CDDT) \* Consult factor for availability of TO-3 Metal Can.

#### FOR FURTHER INFORMATION CALL (714) 898-8121

# TRANS STAR HOLF PRODUCTION DATA SHEET TO STROT BY INTERIOR THE

## ABSOLUTE MAXIMUM RATINGS (Note 1) Operating Junction Temperature Storage Temperature Range ......-65°C to 150°C

Lead Temperature (Soldering, 10 seconds) 300°C Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

# THERMAL DATA

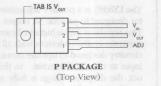
#### P PACKAGE:

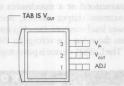
THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{_{ m JT}}$	3.0°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	60°C/W
DD PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{ m JT}$	3.0°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ,	60°C/W*

Junction Temperature Calculation:  $T_1 = T_A + (P_D \times \theta_A)$ . The  $\theta_{14}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

\*  $\theta_{1a}$  can be improved with package soldered to  $0.5 \text{IN}^2$  copper area over backside ground plane or internal power plane.  $\theta_{LA}$  can vary from 20°C/W to > 40°C/W depending on mounting technique.

#### PACKAGE PIN OUTS

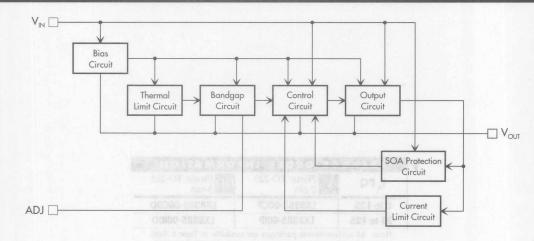




DD PACKAGE (Top View)

200000

#### **BLOCK DIAGRAM**



# 3A LOW DROPOUT POSITIVE ADJUSTABLE REGULATOR

#### PRODUCTION DATA SHEET

#### **ELECTRICAL CHARACTERISTICS**

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the LX8385C with  $0^{\circ}\text{C} \leq \text{T}_{A} \leq 125^{\circ}\text{C}$ , the LX8385I with  $-25^{\circ}\text{C} \leq \text{T}_{A} \leq 125^{\circ}\text{C}$ ;  $V_{\text{IN}} - V_{\text{O}} = 3\text{V}$ ;  $I_{\text{O}} = 3\text{A}$ . Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Cumbal	Took Conditions	LX8385C/8385I			Units
Farameter	Symbol	Test Conditions	Min. Typ. Max.			
Reference Voltage (Note 4)	V <sub>R</sub>	I <sub>o</sub> = 10mA, T <sub>A</sub> = 25°C	1.238	1.250	1.262	٧
		$10\text{mA} \le I_0 \le I_{O(MAX)}$ , $1.5\text{V} \le (V_{IN} - V_0)$ , $V_{IN} \le 20\text{V}$ , $P \le P_{MAX}$	1.225	1.250	1.270	٧
Line Regulation (Note 2)	d V <sub>R</sub> (IN)	$1.5V \le (V_{IN} - V_{O}) \le 7V$ , $I_{O} = 10$ mA	DICTOR S	0.015	0.2	%
	0 - 13	$1.5V \le (V_{IN} - V_{O}) \le 15V, I_{O} = 10mA$	density a	0.035	0.3	%
Load Regulation (Note 2)	dV <sub>R</sub> (L)	$V_{o} \ge V_{REF}, V_{IN} - V_{o} = 3V, 10mA \le I_{o} \le 3A, T_{A} = 25^{\circ}C$	linger add	0.1	0.3	2 V 0 V % % % %
	4,000	$V_{IN} - V_{O} = 3V$ , $10mA \le I_{O} \le 3A$		0.2	0.4	
Thermal Regulation (Note 3)	dVo(P)	$T_A = 25$ °C, 20ms pulse		0.01	0.04	%/W
Ripple Rejection (Note 3)	102015	$V_0 = 5V$ , $f = 120Hz$ , $C_{OUT} = 100\mu f$ Tantalum, $V_{IN} = 6.5V$	is nair ai	artalanan	o tovonio	siff.
	gains ame	$C_{ADJ} = 10 \mu F$ , $T_A = 25  ^{\circ}C$ , $I_O = 3A$	65	83	TO REVENT	
Adjust Pin Current	I <sub>ADJ</sub>	inclinace temperature conflictors, as the laptitud or	HODECT	55	100	μA
Adjust Pin Current Change (Note 4)	Δ I <sub>ADJ</sub>	$10\text{mA} \le I_0 \le I_{O(MAX)}$ , $1.5\text{V} \le (V_{IN} - V_0)$ , $V_{IN} \le 20\text{V}$	ubagou	0.2	5	μА
Dropout Voltage	Δ٧	$\Delta V_{REF} = 1\%$ , $I_{O} = 3A$	rimols 3	1.2	1.5	III V
Minimum Load Current	I <sub>O (MIN)</sub>	V <sub>IN</sub> ≤ 20V = 111	e wied na	2	10	mA
Maximum Output Current (Note 5)	I <sub>O (MAX)</sub>	$V_{IN} - V_{O} \leq 7V$	3	3.5	HESTERN	A
	militie se	V <sub>IN</sub> - V <sub>O</sub> ≤ 12V	2	2.5	a bypas	A
	30Mm	V <sub>IN</sub> - V <sub>O</sub> ≤ 15V	0.11	2	((((A)) #	A
	ETROSEN A	$V_{IN} - V_{O} \le 20V$	0.25	1.2	1 954 56	A
Temperature Stability (Note 3)	dVo(T)	ad output capacitornal questioners as a provincia provin	nhbar atp	0.25	Likes of Lin	%
Long Term Stability (Note 3)	dVo(t)	T <sub>A</sub> = 125°C, 1000 hours	A ID AS	0.3	1 118	%
RMS Output Noise (% of Vour) (Note 3)	V <sub>O RMS</sub>	$T_A = 25$ °C, $10$ Hz $\leq f \leq 10$ kHz	secretary.	0.003	E TOT SESS	%

- Note 2. Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.
- Note 3. These parameters, although guaranteed, are not tested in production.
- Note 4. See Maximum Output Current Section above.
- Note 5.  $I_{O(MAX)}$  is measured under the condition that  $V_{O}$  is forced below its nominal value by 100mV.



legans to meet regulater mappusespace operations. Output specience ratives may be increased with out itmit.

The cyrrin shown in Figure 1 can be useful to chapter the procession spense of anatherists of the negations in a power system under

# 3A LOW DROPOUT POSITIVE ADJUSTABLE REGULATOR

# PRODUCTION DATA SHEET

## APPLICATION NOTES

The LX8385 is an easy to use Low-Dropout (LDO) voltage regulator. It has all of the standard self-protection features expected of a voltage regulator: short circuit protection, safe operating area protection and automatic thermal shutdown if the device temperature rises above approximately 165°C.

Use of an output capacitor is REQUIRED with the LX8385. Please see the table below for recommended minimum capacitor values.

The regulator offers a more tightly controlled reference voltage tolerance and superior reference stability when measured against the older pin-compatible regulator types that it replaces.

#### STABILITY

The output capacitor is part of the regulator's frequency compensation system. Many types of capacitors are available, with different capacitance value tolerances, capacitance temperature coefficients, and equivalent series impedances. For all operating conditions, connection of a 220µF aluminum electrolytic capacitor or a  $47\mu\mathrm{F}$  solid tantalum capacitor between the output terminal and ground will guarantee stable operation.

If a bypass capacitor is connected between the output voltage adjust (ADJ) pin and ground, ripple rejection will be improved (please see the section entitled "RIPPLE REJECTION"). When ADJ pin bypassing is used, the required output capacitor value increases. Output capacitor values of 220µF (aluminum) or 47µF (tantalum) provide for all cases of bypassing the ADJ pin. If an ADJ pin bypass capacitor is not used, smaller output capacitor values are adequate. The table below shows recommended minimum capacitance values for stable operation.

#### RECOMMENDED CAPACITOR VALUES

INPUT	OUTPUT	ADJ
10µF	15µF Tantalum, 100µF Aluminum	None
10µF	47µF Tantalum, 220µF Aluminum	15pF

In order to ensure good transient response from the power supply system under rapidly changing current load conditions, designers generally use several output capacitors connected in parallel. Such an arrangement serves to minimize the effects of the parasitic resistance (ESR) and inductance (ESL) that are present in all capacitors. Cost-effective solutions that sufficiently limit ESR and ESL effects generally result in total capacitance values in the range of hundreds to thousands of microfarads, which is more than adequate to meet regulator output capacitor specifications. Output capacitance values may be increased without limit.

The circuit shown in Figure 1 can be used to observe the transient response characteristics of the regulator in a power system under changing loads. The effects of different capacitor types and values on transient response parameters, such as overshoot and undershoot, can be quickly compared in order to develop an optimum solution.

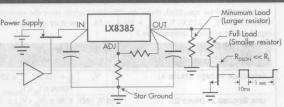


FIGURE 1 — DYNAMIC INPUT and OUTPUT TEST

#### OVERLOAD RECOVERY

Like almost all IC power regulators, the LX8385 is equipped with Safe Operating Area (SOA) protection. The SOA circuit limits the regulator's maximum output current to progressively lower values as the input-to-output voltage difference increases. By limiting the maximum output current, the SOA circuit keeps the amount of power that is dissipated in the regulator itself within safe limits for all values of input-to-output voltage within the operating range of the regulator. The LX8385 SOA protection system is designed to be able to supply some output current for all values of input-to-output voltage, up to the device breakdown voltage.

Under some conditions, a correctly operating SOA circuit may prevent a power supply system from returning to regulated operation after removal of an intermittent short circuit at the output of the regulator. This is a normal mode of operation which can be seen in most similar products, including older devices such as 7800 series regulators. It is most likely to occur when the power system input voltage is relatively high and the load impedance is relatively low.

When the power system is started "cold", both the input and output voltages are very close to zero. The output voltage closely follows the rising input voltage, and the input-to-output voltage difference is small. The SOA circuit therefore permits the regulator to supply large amounts of current as needed to develop the designed voltage level at the regulator output. Now consider the case where the regulator is supplying regulated voltage to a resistive load under steady state conditions. A moderate input-to-output voltage appears across the regulator but the voltage difference is small enough that the SOA circuitry allows sufficient current to flow through the regulator to develop the designed output voltage across the load resistance. If the output resistor is short-circuited to ground, the input-to-output voltage difference across the regulator suddenly becomes larger by the amount of voltage that had appeared across the load resistor. The SOA circuit reads the increased input-tooutput voltage, and cuts back the amount of current that it will permit the regulator to supply to its output terminal. When the short circuit across the output resistor is removed, all the regulator output current will again flow through the output resistor. The maximum current that the regulator can supply to the resistor will be limited by the SOA circuit, based on the large input-to-output voltage across the regulator at the time the short circuit is removed from the output. If this limited current is not sufficient to develop the designed

# 3A LOW DROPOUT POSITIVE ADJUSTABLE REGULATOR

#### PRODUCTION DATA SHEET

#### APPLICATION NOTES

#### OVERLOAD RECOVERY (continued)

voltage across the output resistor, the voltage will stabilize at some lower value, and will *never* reach the designed value. Under these circumstances, it may be necessary to cycle the input voltage down to zero in order to make the regulator output voltage return to regulation.

#### RIPPLE REJECTION

Ripple rejection can be improved by connecting a capacitor between the ADJ pin and ground. The value of the capacitor should be chosen so that the impedance of the capacitor is equal in magnitude to the resistance of R1 at the ripple frequency. The capacitor value can be determined by using this equation:

$$C = 1 / (6.28 * F_p * R1)$$

where: C ≡ the value of the capacitor in Farads;

 $F_R \equiv \text{the ripple frequency in Hz}$  $R1 \equiv \text{the value of resistor R1 in ohms}$ 

At a ripple frequency of 120Hz, with R1 =  $100\Omega$ :

$$C = 1 / (6.28 * 120 Hz * 100\Omega) = 13.3 \mu F$$

The closest equal or larger standard value should be used, in this case, 15µF.

When an ADJ pin bypass capacitor is used, output ripple amplitude will be essentially independent of the output voltage. If an ADJ pin bypass capacitor is not used, output ripple will be proportional to the ratio of the output voltage to the reference voltage:

$$M = V_{OUT}/V_{REF}$$

where: M  $\equiv$  a multiplier for the ripple seen when the ADJ pin is optimally bypassed.  $V_{\text{BFF}} = 1.25 \text{V}.$ 

For example, if  $V_{OUT} = 2.5V$  the output ripple will be:

$$M = 2.5V/1.25V = 2$$

Output ripple will be twice as bad as it would be if the ADJ pin were to be bypassed to ground with a properly selected capacitor.

#### **OUTPUT VOLTAGE**

The LX8385 develops a 1.25V reference voltage between the output and the adjust terminal (See Figure 2). By placing a resistor, R1, between these two terminals, a constant current is caused to flow through R1 and down through R2 to set the overall output voltage. Normally this current is the specified minimum load current of  $10\mathrm{mA}$ . Because I  $_{\mathrm{ADJ}}$  is very small and constant when compared with the current through R1, it represents a small error and can usually be ignored.

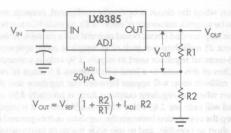


FIGURE 2 — BASIC ADJUSTABLE REGULATOR

#### LOAD REGULATION

Because the LX8385 is a three-terminal device, it is not possible to provide true remote load sensing. Load regulation will be limited by the resistance of the wire connecting the regulator to the load. The data sheet specification for load regulation is measured at the bottom of the package. Negative side sensing is a true Kelvin connection, with the bottom of the output divider returned to the negative side of the load. Although it may not be immediately obvious, best load regulation is obtained when the top of the resistor divider, (R1), is connected directly to the case of the regulator, not to the load. This is illustrated in Figure 3. If R1 were connected to the load, the effective resistance between the regulator and the load would be:

$$R_{peff} = R_p * \left(\frac{R2+R1}{R1}\right)$$

where:  $R_p \equiv Actual parasitic line resistance.$ 

When the circuit is connected as shown in Figure 3, the parasitic resistance appears as its actual value, rather than the higher  $R_{\rm peff}$ 

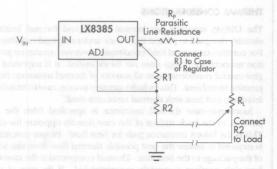


FIGURE 3 — CONNECTIONS FOR BEST LOAD REGULATION

## PRODUCTION DATA SHEET

## APPLICATION NOTES

## LOAD REGULATION (continued)

Even when the circuit is optimally configured, parasitic resistance can be a significant source of error. A 20 mil wide PC trace built from 1 oz. copper-clad circuit board material has a parasitic resistance of about 25 milliohms per inch of its length at room temperature. If a 3-terminal regulator used to supply 2.50 volts is connected by 2 inches of this trace to a load which draws 1.5 amps of current, a 75 millivolt drop will appear between the regulator and the load. Even when the regulator output voltage is precisely 2.50 volts, the load will only see 2.43 volts, which is a 3% error. It is important to keep the connection between the regulator output pin and the load as short as possible, and to use wide traces or heavy-gauge wire.

The minimum specified output capacitance for the regulator should be located near the reglator package. If several capacitors are used in parallel to construct the power system output capacitance, any capacitors beyond the minimum needed to meet the specified requirements of the regulator should be located near the sections of the load that require rapidly-changing amounts of current. Placing capacitors near the sources of load transients will help ensure that power system transient response is not impaired by the effects of trace impedance.

To maintain good load regulation, wide traces should be used on the input side of the regulator, especially between the input capacitors and the regulator. Input capacitor ESR must be small enough that the voltage at the input pin does not drop below  $V_{\mbox{\tiny IN\,OMINO}}$  during transients.

$$V_{IN (MIN)} = V_{OUT} + V_{DROPOUT (MAX)}$$

where: V<sub>IN (MIN)</sub>

 ■ the lowest allowable instantaneous voltage at the input pin.

V<sub>OUT</sub> ≡ the designed output voltage for the

Power supply system.

V\_DROPOUT (MAX) 

■ the specified dropout voltage for the installed regulator.

## THERMAL CONSIDERATIONS

The LX8385 regulator has internal power and thermal limiting circuitry designed to protect the device under overload conditions. For continuous normal load conditions, however, maximum junction temperature ratings must not be exceeded. It is important to give careful consideration to all sources of thermal resistance from junction to ambient. This includes junction to case, case to heat sink interface, and heat sink thermal resistance itself.

Junction-to-case thermal resistance is specified from the IC junction to the back surface of the case directly opposite the die. This is the lowest resistance path for heat flow. Proper mounting is required to ensure the best possible thermal flow from this area of the package to the heat sink. Thermal compound at the case-to-heat-sink interface is strongly recommended. If the case of the device must be electrically isolated, a thermally conductive spacer

can be used, as long as its added contribution to thermal resistance is considered. Note that the case of all devices in this series is electrically connected to the output.

## Example

Given:  $V_{IN} = 5V$   $V_{O} = 2.5V$ ,  $I_{O} = 1.5A$ Ambient Temp.,  $T_{A} = 50^{\circ}C$  $R_{BJT} = 2.7^{\circ}C/W$  for TO-220

Find: Proper Heat Sink to keep IC's junction temperature below 125°C.\*\*

Solution: The junction temperature is:

$$T_{I} = P_{D} (R_{\theta IT} + R_{\theta CS} + R_{\theta SA}) + T_{A}$$

where:  $P_D \equiv Dissipated power$ .

 $R_{\theta jT} \equiv$  Thermal resistance from the junction to the mounting tab of the package.

R<sub>ecs</sub> ≡ Thermal resistance through the interface between the IC and the surface on which it is mounted. (1.0°C/W at 6 in-lbs mounting screw torque.)

R<sub>BSA</sub> ≡ Thermal resistance from the mounting surface to ambient (thermal resistance of the heat sink).

 $T_s \equiv \text{Heat sink temperature.}$ 

$$T_{\underline{J}} \underbrace{T_{C}}_{R_{\theta JT}} \underbrace{T_{C}}_{R_{\theta CS}} \underbrace{T_{S}}_{R_{\theta SA}} \underbrace{T_{A}}_{R}$$

First, find the maximum allowable thermal resistance of the heat sink:

$$R_{\text{BSA}} = \frac{T_{\text{J}} - T_{\text{A}}}{P_{\text{D}}} - (R_{\text{BT}} + R_{\text{BCS}})$$

$$P_{\text{D}} = (V_{\text{IN(MAX)}} - V_{\text{O}}) I_{\text{O}} = (5.0V - 2.5V) \cdot 1.5A$$

$$= 3.75W$$

$$R_{\text{BSA}} = \frac{125^{\circ}\text{C} - 50^{\circ}\text{C}}{3.75W} - (2.7^{\circ}\text{C/W} + 1.0^{\circ}\text{C/W})$$

Next, select a suitable heat sink. The selected heat sink must have  $R_{_{\text{BSA}}} \leq 16.3^{\circ}\text{C/W}.$  Thermalloy heatsink 6230B has  $R_{_{\text{BSA}}} = 12.0^{\circ}\text{C/W}.$  Finally, verify that junction temperature remains within specification using the selected heat sink:

$$T_r = 3.75W (2.7°C/W + 1.0°C/W + 12.0°C/W) + 50°C = 109°C$$

\*\* Although the device can operate up to 150°C junction, it is recommended for long term reliability to keep the junction temperature below 125°C whenever possible.

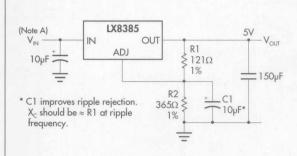


LX8385

## 3A LOW DROPOUT POSITIVE ADJUSTABLE REGULATOR

## PRODUCTION DATA SHEET

## TYPICAL APPLICATIONS



V<sub>IN</sub> (Note A) IN ADJ R1 121Ω C2 100μF

\* Needed if device is far from filter capacitors.

\*\* 
$$V_{OUT} = 1.25V \left(1 + \frac{R2}{R1}\right)$$

FIGURE 4 — IMPROVING RIPPLE REJECTION

FIGURE 5 — 1.2V - 8V ADJUSTABLE REGULATOR

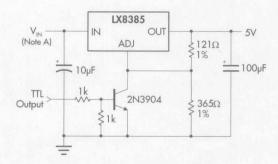


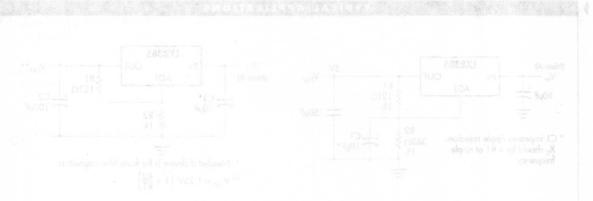
FIGURE 6 — 5V REGULATOR WITH SHUTDOWN

Note A:  $V_{IN (MIN)} = (Intended V_{OUT}) + (V_{DROPOUT (MAX)})$ 



## Notes

## PRODUCTION BREA SHEET



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FIGURE 4 - IMPROVING REPRESENTEN

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Note As Version = (Intebuled Va.) + (Version may)





LX8386

1.5A LOW DROPOUT POSITIVE ADJUSTABLE REGULATOR

THE INFINITE POWER OF INNOVATION PRODUCTION DATA SHEET

## DESCRIPTION

The LX8386 is a positive adjustable regulator designed to provide 1.5A output current. This regulator yields higher efficiency than currently available devices with all internal circuitry is designed to operate down to 1V input to output differential. In this product, the dropout voltage is fully specified as a function of load current. Dropout is guaranteed at a maximum of 1.5V at maximum output current, decreasing at lower load currents. On-chip trimming adjusts the reference voltage to 1%.

The LX8386 device is pin compatible

with earlier 3 terminal regulators, such as 117 series products. While a 10µF output capacitor is required on both input and output of these new devices, this capacitor is generally included in most regulator designs.

The LX8386 quiescent current flows into the load, increasing efficiency. This feature contrasts with PNP regulator, where up to 10% of the output current is wasted as quiescent current. The LX8386I is specified over the full industrial temperature range of -25°C to +125°C and the LX8386C for 0°C to +125°C.

## KEY FEATURES

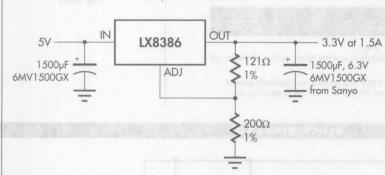
- THREE TERMINAL ADJUSTABLE
- GUARANTEED < 1.5V HEADROOM AT 1.5A
- OUTPUT CURRENT OF 1.5A MINIMUM
- OPERATES DOWN TO 1V DROPOUT
- 0.015% LINE REGULATION
- 0.1% LOAD REGULATION

## APPLICATIONS

- HIGH EFFICIENCY LINEAR REGULATORS
- POST REGULATORS FOR SWITCHING POWER SUPPLIES
- BATTERY CHARGERS
- CONSTANT CURRENT REGULATORS

## PRODUCT HIGHLIGHT

3.3V, 1.5A REGULATOR



## PACKAGE ORDER INFORMATION

T <sub>A</sub> (°C)	Plastic TO-220 3-pin	DD Surface Mount T0-263
0 to 125	LX8386-00CP	LX8386-00CDD
-25 to 125	LX8386-00IP	LX8386-00IDD

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX8386-00CDDT)

## 1.5A Low Dropout Positive Adjustable Regulator

## TARRE ATA & HOLT PRODUCTION DATA SHEET

## ABSOLUTE MAXIMUM RATINGS (Note 1)

Power Dissipation	Internally Limited
Input Voltage	
	20V
Plastic (P, DD Packages)	150°C
Storage Temperature Range	
Lead Temperature (Soldering, 10 seconds)	300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

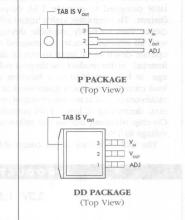
## THERMAL DATA

3.0°C/W
60°C/W
3.0°C/W
60°C/W*

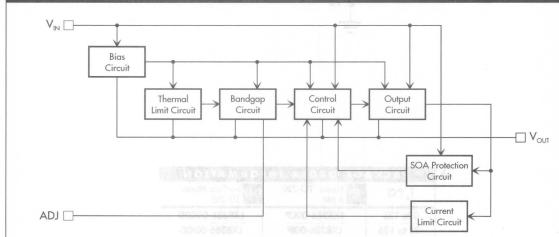
Junction Temperature Calculation:  $T_J = T_A + (P_D \times \theta_{JA})$ . The  $\theta_{JA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

\*  $\theta_{tA}$ can be improved with package soldered to  $0.5 \text{IN}^2$  copper area over backside ground plane or internal power plane.  $\theta_{1a}$  can vary from 20°C/W to > 40°C/W depending on mounting technique.

## PACKAGE PIN OUTS



## BLOCK DIAGRAM





## PRODUCTION DATA SHEET

## **ELECTRICAL CHARACTERISTICS**

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the LX8386C with  $0^{\circ}C \le T_A \le 125^{\circ}C$ , and the LX8386I with  $-25^{\circ}C \le T_A \le 125^{\circ}C$ ;  $V_{IN} - V_O = 3V$ ;  $I_O = 1.5A$ . Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX8386C/8386I			Units
Farameter	Sylliooi	lest conditions	Min.	Тур.	Max.	Oilit
Reference Voltage (Note 4)	V <sub>R</sub>	I <sub>o</sub> = 10mA, T <sub>A</sub> = 25°C	1.238	1.250	1.262	V
		$10\text{mA} \le I_{O} \le I_{O \text{ (MAX)}}, \ 1.5\text{V} \le (V_{IN} - V_{O}), \ V_{IN} \le 14\text{V}, \ P \le P_{MAX}$	1.225	1.250	1.270	٧
Line Regulation (Note 2)	d V <sub>R</sub> (IN)	$1.5V \le (V_{IN} - V_{O}) \le 7V, I_{O} = 10mA$	TRAIN IS	0.015	0.2	%
	0 - 11	$1.5V \le (V_{IN} - V_{O}) \le 14V, I_{O} = 10mA$	511511	0.035	0.3	%
Load Regulation (Note 2)	dV <sub>R</sub> (L)	$V_{o} \ge V_{REF}$ , $V_{IN} - V_{o} = 3V$ , $10mA \le I_{o} \le 1.5A$ , $T_{A} = 25$ °C	78 71 PK	0.1	0.3	%
		$V_{IN} - V_{O} = 3V$ , $10mA \le I_{O} \le 1.5A$		0.15	0.4	%
Thermal Regulation (Note 3)	dVo(P)	T <sub>A</sub> = 25°C, 20ms pulse		0.01	0.04	%/W
Ripple Rejection (Note 3)	(AOE) de	$V_0 = 5V$ , $f = 120Hz$ , $C_{OUT} = 100\mu f$ Tantalum, $V_{IN} = 6.5V$	o hag's	notias d	6-18G114G	ed?
	фио гра	$C_{ADJ} = 10 \mu F$ , $T_A = 25 ° C$ , $I_O = 1.5 A$	65	83		dB
Adjust Pin Current	I <sub>ADJ</sub>	apacilance temperature (verhelints) 23-by http://doi.org/	Roomin	55	100	μA
Adjust Pin Current Change (Note 4)	ΔI <sub>ADJ</sub>	$10\text{mA} \le I_{O} \le I_{O(MAX)}$ , $1.5\text{V} \le (V_{IN} - V_{O})$ , $V_{IN} \le 14\text{V}$	disent	0.2	5	μА
Dropout Voltage	Δ٧	$\Delta V_{REF} = 1\%$ , $I_{O} = 1.5A$	simula 7	1.2	1.5	٧
Minimum Load Current	I <sub>O (MIN)</sub>	V <sub>IN</sub> ≤ 14V	W750 10	2	10	mA
Maximum Output Current (Note 5)	I <sub>O (MAX)</sub>	$V_{IN} - V_{O} \leq 7V$	1.5	2.0	part trac	A
Temperature Stability (Note 3)	dVo(T)	necled benkeen the rought volume . The to supply shi	100 2 1	0.25	seed to a	%
Long Term Stability (Note 3)	dVo(t)	T <sub>A</sub> = 125°C, 1000 hours	groling	0.3	1	%
RMS Output Noise (% of Vour) (Note 3)	V <sub>O RMS</sub>	$T_A = 25^{\circ}C$ , $10Hz \le f \le 10kHz$	BUILTING O	0.003	J. 19-08 . 58	%

Note 2. Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

Note 3. These parameters, although guaranteed, are not tested in production.

Note 4. See Maximum Output Current Section above.

Note 5.  $I_{O\,CMMXO}$  is measured under the condition that  $V_O$  is forced below its nominal value by 100mV.



## PRODUCTION DATA SHEET

## APPLICATION NOTES

The LX8386 is an easy to use Low-Dropout (LDO) voltage regulator. It has all of the standard self-protection features expected of a voltage regulator: short circuit protection, safe operating area protection and automatic thermal shutdown if the device temperature rises above approximately 165°C.

Use of an output capacitor is REQUIRED with the LX8386. Please see the table below for recommended minimum capacitor values.

The regulator offers a more tightly controlled reference voltage tolerance and superior reference stability when measured against the older pin-compatible regulator types that it replaces.

## STABILITY

The output capacitor is part of the regulator's frequency compensation system. Many types of capacitors are available, with different capacitance value tolerances, capacitance temperature coefficients, and equivalent series impedances. For all operating conditions, connection of a 220µF aluminum electrolytic capacitor or a  $47\mu F$  solid tantalum capacitor between the output terminal and ground will guarantee stable operation.

If a bypass capacitor is connected between the output voltage adjust (ADJ) pin and ground, ripple rejection will be improved (please see the section entitled "RIPPLE REJECTION"). When ADJ pin bypassing is used, the required output capacitor value increases. Output capacitor values of 220µF (aluminum) or 47µF (tantalum) provide for all cases of bypassing the ADJ pin. If an ADJ pin bypass capacitor is not used, smaller output capacitor values are adequate. The table below shows recommended minimum capacitance values for stable operation.

## **RECOMMENDED CAPACITOR VALUES**

INPUT	OUTPUT	ADJ
10µF	15pF Tantalum, 100pF Aluminum	None
10µF	47μF Tantalum, 220μF Aluminum	15µF

In order to ensure good transient response from the power supply system under rapidly changing current load conditions, designers generally use several output capacitors connected in parallel. Such an arrangement serves to minimize the effects of the parasitic resistance (ESR) and inductance (ESL) that are present in all capacitors. Cost-effective solutions that sufficiently limit ESR and ESL effects generally result in total capacitance values in the range of hundreds to thousands of microfarads, which is more than adequate to meet regulator output capacitor specifications. Output capacitance values may be increased without limit.

The circuit shown in Figure 1 can be used to observe the transient response characteristics of the regulator in a power system under changing loads. The effects of different capacitor types and values on transient response parameters, such as overshoot and undershoot, can be quickly compared in order to develop an optimum solution.

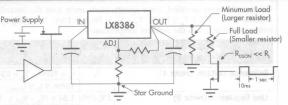


FIGURE 1 — DYNAMIC INPUT and OUTPUT TEST

## **OVERLOAD RECOVERY**

Like almost all IC power regulators, the LX8386 is equipped with Safe Operating Area (SOA) protection. The SOA circuit limits the regulator's maximum output current to progressively lower values as the input-to-output voltage difference increases. By limiting the maximum output current, the SOA circuit keeps the amount of power that is dissipated in the regulator itself within safe limits for all values of input-to-output voltage within the operating range of the regulator. The LX8386 SOA protection system is designed to be able to supply some output current for all values of input-to-output voltage, up to the device breakdown voltage.

Under some conditions, a correctly operating SOA circuit may prevent a power supply system from returning to regulated operation after removal of an intermittent short circuit at the output of the regulator. This is a normal mode of operation which can be seen in most similar products, including older devices such as 7800 series regulators. It is most likely to occur when the power system input voltage is relatively high and the load impedance is relatively low.

When the power system is started "cold", both the input and output voltages are very close to zero. The output voltage closely follows the rising input voltage, and the input-to-output voltage difference is small. The SOA circuit therefore permits the regulator to supply large amounts of current as needed to develop the designed voltage level at the regulator output. Now consider the case where the regulator is supplying regulated voltage to a resistive load under steady state conditions. A moderate input-to-output voltage appears across the regulator but the voltage difference is small enough that the SOA circuitry allows sufficient current to flow through the regulator to develop the designed output voltage across the load resistance. If the output resistor is short-circuited to ground, the input-to-output voltage difference across the regulator suddenly becomes larger by the amount of voltage that had appeared across the load resistor. The SOA circuit reads the increased input-tooutput voltage, and cuts back the amount of current that it will permit the regulator to supply to its output terminal. When the short circuit across the output resistor is removed, all the regulator output current will again flow through the output resistor. The maximum current that the regulator can supply to the resistor will be limited by the SOA circuit, based on the large input-to-output voltage across the regulator at the time the short circuit is removed from the output. If this limited current is not sufficient to develop the designed

## PRODUCTION DATA SHEET

## APPLICATION NOTES

## **OVERLOAD RECOVERY** (continued)

voltage across the output resistor, the voltage will stabilize at some lower value, and will *never* reach the designed value. Under these circumstances, it may be necessary to cycle the input voltage down to zero in order to make the regulator output voltage return to regulation.

## RIPPLE REJECTION

Ripple rejection can be improved by connecting a capacitor between the ADJ pin and ground. The value of the capacitor should be chosen so that the impedance of the capacitor is equal in magnitude to the resistance of R1 *at the ripple frequency*. The capacitor value can be determined by using this equation:

$$C = 1 / (6.28 * F_p * R1)$$

where:  $C \equiv \text{the value of the capacitor in Farads};$ 

aselect an equal or larger standard value.

 $F_R \equiv$  the ripple frequency in Hz

R1 = the value of resistor R1 in ohms

At a ripple frequency of 120Hz, with R1 =  $100\Omega$ :

$$C = 1 / (6.28 * 120 Hz * 100\Omega) = 13.3 \mu F$$

The closest equal or larger standard value should be used, in this case. 15uF

When an ADJ pin bypass capacitor is used, output ripple amplitude will be essentially independent of the output voltage. If an ADJ pin bypass capacitor is not used, output ripple will be proportional to the ratio of the output voltage to the reference voltage:

$$M = V_{OUT}/V_{REF}$$

where: M  $\equiv$  a multiplier for the ripple seen when the ADJ pin is optimally bypassed.  $V_{\text{NEF}}$  = 1.25V.

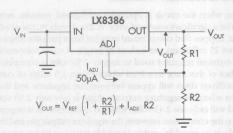
For example, if  $V_{our} = 2.5V$  the output ripple will be:

$$M = 2.5V/1.25V = 2$$

Output ripple will be twice as bad as it would be if the ADJ pin were to be bypassed to ground with a properly selected capacitor.

## **OUTPUT VOLTAGE**

The LX8386 develops a 1.25V reference voltage between the output and the adjust terminal (See Figure 2). By placing a resistor, R1, between these two terminals, a constant current is caused to flow through R1 and down through R2 to set the overall output voltage. Normally this current is the specified minimum load current of 10mA. Because  $I_{\text{ADJ}}$  is very small and constant when compared with the current through R1, it represents a small error and can usually be ignored.



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## LOAD REGULATION

Because the LX8386 is a three-terminal device, it is not possible to provide true remote load sensing. Load regulation will be limited by the resistance of the wire connecting the regulator to the load. The data sheet specification for load regulation is measured at the bottom of the package. Negative side sensing is a true Kelvin connection, with the bottom of the output divider returned to the negative side of the load. Although it may not be immediately obvious, best load regulation is obtained when the top of the resistor divider, (R1), is connected *directly* to the case of the regulator, *not to the load*. This is illustrated in Figure 3. If R1 were connected to the load, the effective resistance between the regulator and the load would be:

$$R_{peff} = R_p * \left(\frac{R2+R1}{R1}\right)$$

where:  $R_p \equiv Actual parasitic line resistance.$ 

When the circuit is connected as shown in Figure 3, the parasitic resistance appears as its actual value, rather than the higher  $R_{\rm mat}$ 

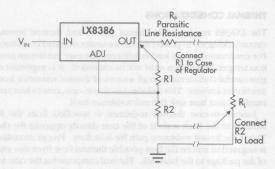


FIGURE 3 — CONNECTIONS FOR BEST LOAD REGULATION

## PRODUCTION DATA SHEET

## APPLICATION NOTES

## LOAD REGULATION (continued)

Even when the circuit is optimally configured, parasitic resistance can be a significant source of error. A 20 mil wide PC trace built from 1 oz. copper-clad circuit board material has a parasitic resistance of about 25 milliohms per inch of its length at room temperature. If a 3-terminal regulator used to supply 2.50 volts is connected by 2 inches of this trace to a load which draws 1.5 amps of current, a 75 millivolt drop will appear between the regulator and the load. Even when the regulator output voltage is precisely 2.50 volts, the load will only see 2.43 volts, which is a 3% error. It is important to keep the connection between the regulator output pin and the load as short as possible, and to use wide traces or heavy-gauge wire.

The minimum specified output capacitance for the regulator should be located near the reglator package. If several capacitors are used in parallel to construct the power system output capacitance, any capacitors beyond the minimum needed to meet the specified requirements of the regulator should be located near the sections of the load that require rapidly-changing amounts of current. Placing capacitors near the sources of load transients will help ensure that power system transient response is not impaired by the effects of trace impedance.

To maintain good load regulation, wide traces should be used on the input side of the regulator, especially between the input capacitors and the regulator. Input capacitor ESR must be small enough that the voltage at the input pin does not drop below V<sub>IN OND</sub> during transients.

$$V_{IN (MIN)} = V_{OUT} + V_{DROPOUT (MAX)}$$

where:  $V_{IN (MIN)} \equiv$  the lowest allowable instantaneous voltage at the input pin.

Voltage at the input yoltage for the  $V_{\text{DROPOUT (MAX)}} \equiv \text{both system.}$  by the specified dropout voltage

for the installed regulator.

## THERMAL CONSIDERATIONS

The LX8386 regulator has internal power and thermal limiting circuitry designed to protect the device under overload conditions. For continuous normal load conditions, however, maximum junction temperature ratings must not be exceeded. It is important to give careful consideration to all sources of thermal resistance from junction to ambient. This includes junction to case, case to heat sink interface, and heat sink thermal resistance itself.

Junction-to-case thermal resistance is specified from the IC junction to the back surface of the case directly opposite the die. This is the lowest resistance path for heat flow. Proper mounting is required to ensure the best possible thermal flow from this area of the package to the heat sink. Thermal compound at the case-toheat-sink interface is strongly recommended. If the case of the device must be electrically isolated, a thermally conductive spacer can be used, as long as its added contribution to thermal resistance is considered. Note that the case of all devices in this series is electrically connected to the output.

## Example

Given:  $V_{IN} = 5V$   $V_{O} = 2.5V$ ,  $I_{O} = 1.5A$ Ambient Temp., T<sub>A</sub> = 50°C  $R_{BIT} = 2.7^{\circ}C/W$  for TO-220

Find: Proper Heat Sink to keep IC's junction temperature below 125°C.\*\*

Solution: The junction temperature is:

 $T_{_{\rm I}} = P_{_{\rm D}} (R_{_{\rm \theta IT}} + R_{_{\rm \theta CS}} + R_{_{\rm \theta SA}}) + T_{_{\rm A}}$ 

where:  $P_D \equiv Dissipated power$ .

 $R_{\rm eff} \equiv Thermal resistance from the junction to the$ mounting tab of the package.

 $R_{BCS} \equiv$  Thermal resistance through the interface between the IC and the surface on which it is mounted. (1.0°C/W at 6 in-lbs mounting screw torque.)

 $R_{\rm BSA} \equiv$  Thermal resistance from the mounting surface to ambient (thermal resistance of the heat sink).

T<sub>c</sub> ≡ Heat sink temperature.

$$T_{\underline{J}} \underbrace{T_{C} \underbrace{T_{S}}_{R_{\theta J T}} T_{A}}_{R_{\theta C S}}$$

First, find the maximum allowable thermal resistance of the

$$R_{\text{BSA}} = \frac{T_{\text{J}} - T_{\text{A}}}{P_{\text{D}}} - (R_{\text{BJT}} + R_{\text{BCS}})$$

$$P_{\text{D}} = (V_{\text{IN(MAX)}} - V_{\text{O}}) I_{\text{O}} = (5.0V - 2.5V) * 1.5A$$

$$= 3.75W$$

$$R_{\text{BSA}} = \frac{125^{\circ}\text{C} - 50^{\circ}\text{C}}{3.75W} - (2.7^{\circ}\text{C/W} + 1.0^{\circ}\text{C/W})$$

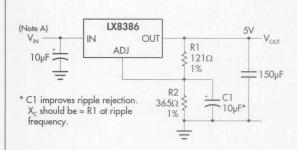
Next, select a suitable heat sink. The selected heat sink must have  $R_{_{\Theta SA}} \le 16.3$ °C/W. Thermalloy heatsink 6230B has  $R_{_{\Theta SA}} = 12.0$ °C/W. Finally, verify that junction temperature remains within specification using the selected heat sink:

$$T_1 = 3.75W (2.7°C/W + 1.0°C/W + 12.0°C/W) + 50°C = 109°C$$

\*\* Although the device can operate up to 150°C junction, it is recommended for long term reliability to keep the junction temperature below 125°C whenever possible.

## PRODUCTION DATA SHEET

## TYPICAL APPLICATIONS



OUT ₹R1 ₹121Ω (Note A) ADJ C1\* 100pF ₹ R2 1k

LX8386

\* Needed if device is far from filter capacitors.

\*\*  $V_{OUT} = 1.25V \left(1 + \frac{R2}{R1}\right)$ 

FIGURE 4 — IMPROVING RIPPLE REJECTION

FIGURE 5 — 1.2V - 8V ADJUSTABLE REGULATOR

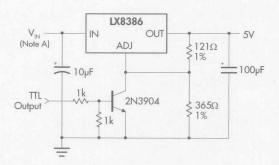


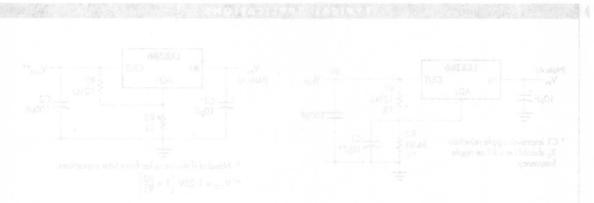
FIGURE 6 — 5V REGULATOR WITH SHUTDOWN

Note A:  $V_{IN (MIN)} = (Intended V_{OUT}) + (V_{DROPOUT (MAX)})$ 



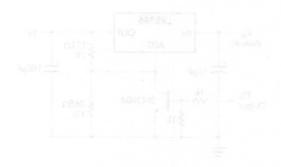
## Notes

## TRIBE BALL SALET



MOLBIES -- 1.3V - BY ADJUSTAG E RUGULATOR

MORTOSLES RUNGS PARTYDONAL ...... & RALLISON



PROBLEM -- SY REGULATOR WITH SHUTDOWN



LX8554

5A Extremely Low Dropout Positive Adjustable Regulator

THE INFINITE POWER OF INNOVATION PRELIMINARY DATA SHEET

## DESCRIPTION

The LX8554 is a very low dropout three terminal adjustable regulator with a minimum of 5A output current. Pentium® and Power PC® applications requiring fast transient response are ideally suited for this product family. The LX8554 is guaranteed to have < 1V at 5A dropout voltage making it ideal to provide well regulated outputs of 2.5V to 3.6V wih input supply as low as 4.75V.

Current limit is trimmed above 5.1A to ensure adequate output current and controlled short-circuit current. Onchip thermal limiting provides protection against any combination of overload that would create excessive junction temperatures.

The LX8554 is available in both the through-hole and surface-mount versions of the industry standard 3-pin TO-220 / TO-263 power packages.

The LX8554 is ideal for use in multiple processor applications where output voltage is jumper selected. The LX8554 offers precision output as well as low supply operation (see application below). For higher current applications see the LX8584.

## KEY FEATURES

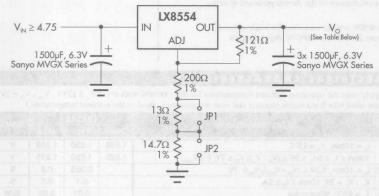
- GUARANTEED < 1V HEADROOM AT 5A
- OUTPUT CURRENT OF 5A MINIMUM
- ☐ FAST TRANSIENT RESPONSE
- 1% VOLTAGE REFERENCE INITIAL ACCURACY
- □ OUTPUT SHORT-CIRCUIT PROTECTION
- BUILT-IN THERMAL SHUTDOWN

## APPLICATIONS

- PENTIUM SUPPLIES
- POWER PC SUPPLIES
- MICROPROCESSOR SUPPLIES
- LOW VOLTAGE LOGIC SUPPLIES
- BATTERY POWERED CIRCUIT
- POST REGULATOR FOR SWITCHING SUPPLY
- LXE9001 EVALUATION BOARD FOR PENTIUM APPLICATIONS AVAILABLE. CONSULT FACTORY.

## PRODUCT HIGHLIGHT

TYPICAL APPLICATION OF THE LX8554 IN A FLEXIBLE MOTHERBOARD WITH OUTPUT VOLTAGE SELECTABLE VIA JUMPERS "JP1" AND "JP2"



JP1	JP2	OUTPUT VOLTAGE
Open	Open	3.6V
Open	Short	3.45V
Short	Short	3.3V
	Open Open	Open Open Open Short

## PACKAGE ORDER INFORMATION DD Plastic T0-263 Plastic TO-220 TA (°C) 3-pin 0 to 125 LX8554-00CP LX8554-00CDD

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX8554-00CDDT)

## LX8554

## 5A Extremely Low Dropout Positive Adjustable Regulator

## PRELIMINARY DATA SHEET

## ABSOLUTE MAXIMUM RATINGS (Note 1) Power Dissipation ...... Input to Output Voltage Differential..... Operating Junction Temperature Plastic (P Package) Storage Temperature Range .....-65°C to 150°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

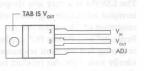
## THERMAL DATA

P PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{_{\mathrm{JT}}}$	2.7°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	60°C/W
DD PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{_{ m JT}}$	2.7°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	60°C/W *

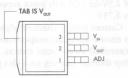
Junction Temperature Calculation:  $T_1 = T_A + (P_D \times \theta_{IA})$ .

The  $\theta_{tA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

\*  $\theta_{1a}$  can be improved with package soldered to 0.5 IN $^2$  copper area over backside ground plane or internal power plane.  $\theta_{10}$  can vary from 20°C/W to > 40°C/W depending on mounting technique.



P PACKAGE (Top View)



DD PACKAGE

(Top View)

## **ELECTRICAL CHARACTERISTICS**

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the LX8585C with 0°C  $\leq$  T<sub>a</sub>  $\leq$  125°C; V<sub>IN</sub> - V<sub>O</sub> = 3V I<sub>0</sub> = 5A. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

	Cumbal	Test Conditions		LX8585	7	Units
Parameter	Symbol	Test Conditions	Min.	Тур.	Max.	Units
Reference Voltage	V <sub>R</sub>	I <sub>o</sub> = 10mA, T <sub>A</sub> = 25°C	1.238	1.250	1.262	٧
		$10\text{mA} \le I_{O} \le 5\text{A}, \ 1.5\text{V} \le (V_{IN} - V_{O}), \ V_{IN} \le 7\text{V}, \ P \le P_{MAX}$	1.225	1.250	1.275	٧
Line Regulation (Note 2)	dV <sub>R</sub> (IN)	$I_{o} = 10 \text{mA}, 1.5 \text{V} \le (V_{iN} - V_{OUT}), V_{iN} \le 7 \text{V}$		0.035	0.2	%
Load Regulation (Note 2)	d V <sub>R</sub> (L)	$V_{IN} - V_{O} = 3V$ , $10mA \le I_{O} \le 5A$		0.1	0.5	%
Thermal Regulation	dVo(P)	T <sub>A</sub> = 25°C, 20ms pulse		0.01	0.02	%/W
Ripple Rejection (Note 3)		$V_0 = 3.3V, f = 120Hz, C_{OUT} = 100\mu f$ Tantalum, $V_{IN} = 5V$				
		$C_{ADJ} = 10 \mu F$ , $T_A = 25 ^{\circ}C$ , $I_O = 5A$	60	83		dB
Adjust Pin Current	I <sub>ADJ</sub>	Short 3.45V	rasc	55	100	μА
Adjust Pin Current Change	$\Delta I_{ADJ}$	$10\text{mA} \le I_{O} \le 5\text{A}, \ 1.5\text{V} \le (V_{IN} - V_{O}), \ V_{IN} \le 7\text{V}$	710	0.2	5	μA
Dropout Voltage	ΔV	$\Delta V_{REF} = 1\%$ , $I_{O} = 5A$		0.8	1	٧
Minimum Load Current	I <sub>O(MIN)</sub>	$V_{IN} \leq 7V$		2	10	mA
Maximum Output Current (Note 4)	I <sub>O(MAX)</sub>	$1.4V \le (V_{IN} - V_{OUT}), V_{IN} \le 7V$	5.1	7		Α
Temperature Stability (Note 3)	d V <sub>o</sub> (t)			0.25		%
Long Term Stability (Note 3)	dVo(t)	T <sub>A</sub> = 125°C, 1000 hrs			1	%
RMS Output Noise (% of V <sub>o</sub> ) (Note 3)	V <sub>O RMS</sub>	$T_A = 125$ °C, $10Hz \le f \le 10kHz$		0.003		%

Note 2. Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

Note 3. These parameters, although guaranteed, are not tested in production.

Note 4. I<sub>O (MAX)</sub> is measured under the condition that V<sub>O</sub> is forced below its nominal value by 100mV.



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LX8582A

8.5A LOW DROPOUT POSITIVE ADJUSTABLE REGULATOR

THE INFINITE POWER OF INNOVATION

PRELIMINARY DATA SHEET

## DESCRIPTION

The LX8582A is a low dropout three terminal adjustable regulator with a minimum of 8.5A output current. Processor applications such as the Cyrix\* M1, Pentium\* and Power PC\* applications requiring fast transient response are ideally suited for this product family. The LX8582A is **guaranteed to have < 1.3V at 8.5A** and is ideal to provide well regulated outputs of 2.5V to 3.6V using a 5V input supply.

Current limit is trimmed above 8.6A to ensure adequate output current and

controlled short-circuit current. Onchip thermal limiting provides protection against any combination of overload that would create excessive junction temperatures.

The LX8582A is available in both the through-hole versions of the industry standard 3-pin TO-220 and TO-247 power packages.

For use in VRE applications, the LX1431 Programmable Reference in conjunction with this regulator offers precision output voltage. See the LX1431 data sheet for information on this product.

## KEY FEATURES

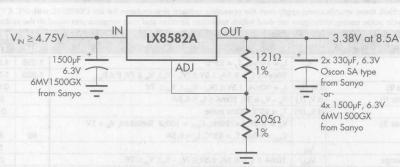
- **■** GUARANTEED < 1.3V HEADROOM AT 8.5A
- OUTPUT CURRENT OF 8.5A MINIMUM
- ☐ FAST TRANSIENT RESPONSE
- 1% VOLTAGE REFERENCE INITIAL ACCURACY
- OUTPUT SHORT CIRCUIT PROTECTION
- BUILT-IN THERMAL SHUTDOWN

## APPLICATIONS

- CYRIX M1 APPLICATIONS
- PENTIUM SUPPLIES
- POWER PC SUPPLIES
- MICROPROCESSOR SUPPLIES
- LOW VOLTAGE LOGIC SUPPLIES
- POST REGULATOR FOR SWITCHING SUPPLY
- LXE9001 EVALUATION BOARD FOR PENTIUM APPLICATIONS AVAILABLE. CONSULT FACTORY.

## PRODUCT HIGHLIGHT

CYRIX M1 VOLTAGE SUPPLY 3.38V, 8.5A REGULATOR



Application of the LX8582A for the Cyrix M1 processor family. This circuit is designed to have less than 130mV dynamic response to a 8.5A load transient.

## | PACKAGE ORDER INFORMATION | T<sub>A</sub> (°C) | Dropout Voltage | P | Plastic TO-220 3-pin | V | Plastic TO-247 3-terminal | V | Pla

## IX8582A

## 8.5A LOW DROPOUT POSITIVE ADJUSTABLE REGULATOR

## TERRE ATA O YEAR PRELIMINARY DATA SHEET

## Power Dissipation Internally Limited Input Voltage 10V Input to Output Voltage 110V Operating Junction Temperature Plastic (P Package) 150°C Storage Temperature Range 65°C to 150°C Lead Temperature (Soldering, 10 seconds) 300°C Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal,

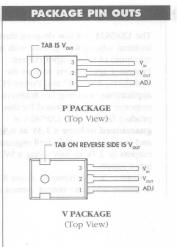
## THERMAL DATA

## P PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{_{ m JT}}$	2.7°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	60°C/W
V PACKAGE: NOT NOTALIDEST TROT III	
THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{_{ m JT}}$	1.6°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ,	35°C/W

Junction Temperature Calculation:  $T_I = T_A + (P_D \times \theta_{IA})$ .

The  $\theta_{j,k}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.



## **ELECTRICAL CHARACTERISTICS**

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the LX8582AC with  $0^{\circ}$ C  $\leq$   $T_A \leq$  125°C;  $V_{IN}$  -  $V_O =$  3V;  $I_A =$  8.5A. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter		Test Conditions	LX8582A			Units
rarameter	Symbol	lest conditions	Min.	Тур.	Max.	Ullits
Reference Voltage	V <sub>R</sub>	I <sub>o</sub> = 10mA, T <sub>A</sub> = 25°C	1.238	1.250	1.262	٧
	211	$10\text{mA} \le I_{O} \le 8.5\text{A}, 1.5\text{V} \le (V_{IN} - V_{O}), V_{IN} \le 7\text{V}, P \le P_{MAX}$	1.225	1.250	1.275	٧
Line Regulation (Note 2)	dV <sub>R</sub> (IN)	$I_0 = 10 \text{mA}, 1.5 \text{V} \le (V_{IN} - V_{OUT}), V_{IN} \le 7 \text{V}$	3	0.035	0.2	%
Load Regulation (Note 2)	dV <sub>R</sub> (L)	$V_{IN} - V_{O} = 3V$ , $10mA \le I_{O} \le 8.5A$	10,10	0.1	0.5	%
Thermal Regulation	dVo(P)	T <sub>A</sub> = 25°C, 20ms pulse		0.01	0.02	%/W
Ripple Rejection (Note 3)	्राचे । जिल्ला	$V_O = 3.3V$ , $f = 120Hz$ , $C_{OUT} = 100\mu f$ Tantalum, $V_{IN} = 5V$ $C_{ADJ} = 10\mu F$ , $T_A = 25^{\circ}C$ , $I_O = 8.5A$	60	83		dB
Adjust Pin Current	I <sub>ADJ</sub>			55	100	μА
Adjust Pin Current Change	$\Delta I_{ADJ}$	$10\text{mA} \le I_{O} \le 8.5\text{A}, 1.5\text{V} \le (V_{IN} - V_{O}), V_{IN} \le 7\text{V}$		0.2	5	μА
Dropout Voltage	ΔV	$\Delta V_{REF} = 1\%$ , $I_{O} = 8.5A$		1.1	1.3	٧
Minimum Load Current	I <sub>O(MIN)</sub>	V <sub>IN</sub> ≤ 7V	a dere A	2	10	mA
Maximum Output Current (Note 4)	I <sub>O(MAX)</sub>	$1.4V \le (V_{IN} - V_{OUT})$ , $V_{IN} \le 7V$ and a proper force an armonic virial $I$	8.6	9.2		Α
Temperature Stability	dVo(T)			0.25		%
Long Term Stability	d V <sub>o</sub> (t)	T <sub>A</sub> = 125°C, 1000 hrs			1	%
RMS Output Noise (% of V <sub>o</sub> )	V <sub>O RMS</sub>	$T_A = 25$ °C, $10Hz \le f \le 10kHz$		0.003		%

Note 2. Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

Note 3. These parameters, although guaranteed, are not tested in production.

Note 4. I<sub>O (MAX)</sub> is measured under the condition that V<sub>O</sub> is forced below its nominal value by 100mV.

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## LX8584/8584A/8584B

7A LOW DROPOUT POSITIVE ADJUSTABLE REGULATOR

THE INFINITE POWER OF INNOVATION

PRELIMINARY DATA SHEET

## DESCRIPTION

The LX8584/84A/84B are low dropout three terminal adjustable regulators with a minimum of 7A output current. Pentium® and Power PC® applications requiring fast transient response are ideally suited for this product family. The LX8584A is guaranteed to have < 1.2V at 7A and the LX8584/84B < 1.4V at 7A dropout voltage, making them ideal to provide well regulated outputs of 2.5V to 3.6V using a 5V input supply. In addition, the LX8584B also offers ±1% maximum voltage reference accuracy over temperature.

Current limit is trimmed above 7.1A

to ensure adequate output current and controlled short-circuit current. Onchip thermal limiting provides protection against any combination of overload that would create excessive junction temperatures.

The LX8584/84A are available in both the through-hole versions of the industry standard 3-pin TO-220 and TO-247 power packages.

The LX1431 Programmable Reference in conjunction with the LX8584 7A LDO offer precision output voltage (see application below) and are ideal for use in VRE applications.

## KEY FEATURES

- GUARANTEED 1% VOLTAGE ACCURACY OVER TEMPERATURE (LX8584B)
- GUARANTEED < 1.2V HEADROOM AT 7A (LX8584A)
- GUARANTEED < 1.4V HEADROOM AT 7A (LX8584/84B)
- OUTPUT CURRENT OF 7A MINIMUM
- ☐ FAST TRANSIENT RESPONSE
- 1% VOLTAGE REFERENCE INITIAL ACCURACY
- OUTPUT SHORT CIRCUIT PROTECTION
- BUILT-IN THERMAL SHUTDOWN

## APPLICATIONS

- PENTIUM SUPPLIES
- POWER PC SUPPLIES

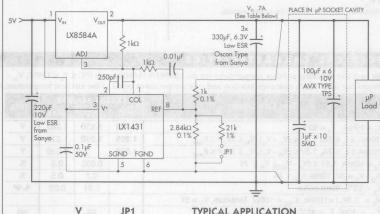
3

Input / Output Differential

- MICROPROCESSOR SUPPLIES
- LOW VOLTAGE LOGIC SUPPLIES
- POST REGULATOR FOR SWITCHING SUPPLY
- LXE9001 EVALUATION BOARD FOR PENTIUM APPLICATIONS AVAILABLE. CONSULT FACTORY.

## PRODUCT HIGHLIGHT

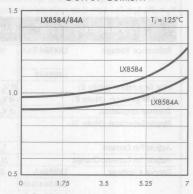
THE APPLICATION OF THE LX8584A & LX1431 IN A 75 & 166MHz P54C PROCESSORS USING 3.3V CACHE



V <sub>o</sub> JP1		TYPICAL APPLICATION
3.50	Short	120/166MHz, VRE, 3.3V Cache
3.38	Open	75/90/100/133MHz, STND, 3.3V Cache

Thick traces represent high current traces which must be low resistance / low inductance traces in order to achieve good transient response.

## DROPOUT VOLTAGE VS.



Output Current - (A)

P	ACKAGE	ORDER INFORI	MATION
T <sub>A</sub> (°C)	Dropout Voltage	P Plastic TO-220 3-pin	V Plastic TO-247 3-terminal
cycle, Changes	1.4V	LX8584-00CP	LX8584-00CV
0 to 125	1.40	LX8584B-00CP	LX8584B-00CV
	1.2V	LX8584A-00CP	LX8584A-00CV

## LX8584/8584A/8584B

## 7A LOW DROPOUT POSITIVE ADJUSTABLE REGULATOR

## THE PRELIMINARY DATA SHEET

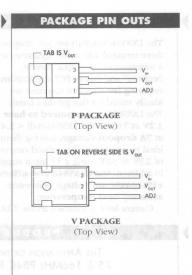
## 

## THERMAL DATA

## P PACKAGE:

2.7°C/W
60°C/W
1.6°C/W
35°C/W

Junction Temperature Calculation:  $T_j = T_A + (P_D \times \theta_{jA})$ . The  $\theta_{jA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.



## ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the LX8584/84A/84BC with  $0^{\circ}$ C  $\leq$   $T_{A} \leq$  125°C;  $V_{IN} - V_{O} = 3V$ ;  $V_{O} = 3V$ ;  $V_{O} = 7A$ . Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Cumbal	Test Conditions	LX8	584/84A	/84B	Units
Faralleter	Symbol	Test Conditions	Min.	Тур.	Max.	Ullits
Reference Voltage LX8584/84	A V <sub>R</sub>	I <sub>o</sub> = 10mA, T <sub>A</sub> = 25°C	1.238	1.250	1.262	٧
	1 8	$10\text{mA} \le I_{O} \le 7\text{A}, \ 1.5\text{V} \le (V_{IN} - V_{O}), \ V_{IN} \le 7\text{V}, \ P \le P_{MAX}$	1.225	1.250	1.275	V
LX8584B	1 1	$10\text{mA} \le I_{O} \le 7\text{A}, \ 1.5\text{V} \le (V_{IN} - V_{O}), \ V_{IN} \le 7\text{V}, \ P \le P_{MAX}$	1.238	VIII	1.262	٧
Line Regulation (Note 2)	dV <sub>R</sub> (IN)	$I_{o} = 10 \text{mA}, 1.5 \text{V} \le (V_{IN} - V_{OUT}), V_{IN} \le 7 \text{V}$	1	0.035	0.2	%
Load Regulation (Note 2)	dV <sub>R</sub> (L)	$V_{IN} - V_{O} = 3V, 10mA \le I_{O} \le 7A$		0.1	0.5	%
Thermal Regulation	dVo(P)	T <sub>A</sub> = 25°C, 20ms pulse		0.01	0.02	%/W
Ripple Rejection (Note 3)	0	$V_{o} = 3.3V$ , f =120Hz, $C_{out} = 100\mu f$ Tantalum, $V_{iN} = 5V$				
	1 6	$C_{ADJ} = 10 \mu F$ , $T_A = 25 ° C$ , $I_O = 7 A$	60	83		dB
Adjust Pin Current	I <sub>ADJ</sub>	orbaniva a and standardor	front2	55	100	μА
Adjust Pin Current Change	$\Delta I_{ADJ}$	$10\text{mA} \le I_{O} \le 7\text{A}, 1.5\text{V} \le (V_{IN} - V_{O}), V_{IN} \le 7\text{V}$	macon (C)	0.2	5	μA
Dropout Voltage LX8584A	ΔV	$\Delta V_{REF} = 1\%$ , $I_{O} = 7A$	1	1.1	1.2	٧
LX8584/84	В	$\Delta V_{REF} = 1\%$ , $I_{O} = 7A$	digird horses	1.2	1.4	٧
LX8584/84	В	$\Delta V_{REF} = 1\%$ , $I_O = 6A$ instants a boson paratrious ad sub-	o al re	1.1	1.3	٧
Minimum Load Current	I <sub>O(MIN)</sub>	$V_{IN} \leq 7V$		2	10	mA
Maximum Output Current (Note 4)	I <sub>O(MAX)</sub>	$1.4V \le (V_{IN} - V_{OUT}), V_{IN} \le 7V$	7.1	8		Α
Temperature Stability	dVo(T)	Definition was to a company as a second		0.25		%
Long Term Stability	dVo(t)	T <sub>A</sub> = 125°C, 1000 hrs			1	%
RMS Output Noise (% of V <sub>o</sub> )	truminal	$V_{ORMS}$ $T_A = 25^{\circ}C$ , $10Hz \le f \le 10kHz$		0.003		%

Note 2. Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

Note 3. These parameters, although guaranteed, are not tested in production.

Note 4.  $I_{O(MAX)}$  is measured under the condition that  $V_O$  is forced below its nominal value by 100mV.



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## LX8585/8585A

4.6A LOW DROPOUT POSITIVE ADJUSTABLE REGULATOR

THE INFINITE POWER OF INNOVATION PRODUCTION DATA SHEET

## DESCRIPTION

The LX8585/85A are low dropout three terminal adjustable regulators with a minimum of 4.6A output current. Pentium® and Power PC® applications requiring fast transient response are ideally suited for this product family. The LX8585A is guaranteed to have < 1.2V at 4.6A, while the LX8585 are specified for 1.4V, making them ideal to provide well regulated outputs of 2.5V to 3.6V using a 5V input supply.

Current limit is trimmed above 4.6A to ensure adequate output current and controlled short-circuit current. On-chip

thermal limiting provides protection against any combination of overload that would create excessive junction tempera-

The LX8585/85A family is available in both the through-hole and surface-mount versions of the industry standard 3-pin TO-220 / TO-263 power packages.

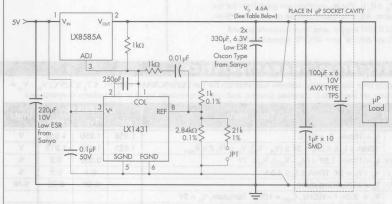
The LX1431 Programmable Reference and LX8585A offer precision output voltage and are ideal for use in VRE applications (see application below). For higher current applications see the LX8584 data sheet.

## KEY FEATURES

- GUARANTEED < 1.2V HEADROOM AT 4.6A
- GUARANTEED < 1.4V HEADROOM AT 4.6A
- GUARANTEED < 1.3V HEADROOM AT 3A
- OUTPUT CURRENT OF 4.6A MINIMUM
- FAST TRANSIENT RESPONSE
- 1% VOLTAGE REFERENCE INITIAL **ACCURACY**
- □ OUTPUT SHORT CIRCUIT PROTECTION
- BUILT-IN THERMAL SHUTDOWN

## PRODUCT HIGHLIGHT

THE APPLICATION OF THE LX8585A & LX1431 IN A 75 & 166MHz P54C Processors Using 5V Cache



Vo	JP1	TYPICAL APPLICATION
3.50	Short	120/166MHz, VRE, 5V Cache
3.38	Open	75/90/100/133MHz, STND, 5V Cache

Thick traces represent high current traces which must be low resistance / low inductance traces in order to achieve good transient response.

## APPLICATIONS

- PENTIUM SUPPLIES
- POWER PC SUPPLIES
- MICROPROCESSOR SUPPLIES
- LOW VOLTAGE LOGIC SUPPLIES
- BATTERY POWERED CIRCUIT
- POST REGULATOR FOR SWITCHING SUPPLY
- LXE9001 EVALUATION BOARD FOR PENTIUM APPLICATIONS AVAILABLE CONSULT FACTORY.

P	ACKAGE	ORDER INFOR	MATION
T <sub>A</sub> (°C)	Dropout Voltage	P Plastic TO-220 3-pin	DD Plastic T0-263 3-pin
0 to 125	1.4V	LX8585-00CP	LX8585-00CDD
	1.2V	LX8585A-00CP	LX8585A-00CDD

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX8585A-00CDDT)

## LX8585/8585A

## 4.6A LOW DROPOUT POSITIVE ADJUSTABLE REGULATOR

## THE ATAC MOST PRODUCTION DATA SHEET

## ABSOLUTE MAXIMUM RATINGS (Note 1) Input Voltage ..... Input to Output Voltage Differential ..... Operating Junction Temperature Plastic (P, DD Package) ..... Storage Temperature Range ......-65°C to 150°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

## THERMAL DATA

## P PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{_{JT}}$	3.0°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	60°C/W
DD PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{_{ m JT}}$	3.0°C/W
THEDMAL DESISTANCE, ILINCTION TO AMBIENT A	60°C/W*

Junction Temperature Calculation:  $T_i = T_A + (P_D \times \theta_{iA})$ . The  $\theta_{iA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

\*  $\theta_{i,k}$  can be improved with package soldered to  $0.5 \text{IN}^2$  copper area over backside ground plane or internal power plane.  $\theta_{\rm u}$  can vary from 20°C/W to > 40°C/W depending on mounting technique.

## TAB IS Vout P PACKAGE (Top View) TAB IS V DD PACKAGE (Top View)

## **ELECTRICAL CHARACTERISTICS**

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the LX8585C/85AC with 0°C ≤ T<sub>a</sub> ≤ 125°C; V<sub>IN</sub> - V<sub>O</sub> = 3V; I<sub>0</sub> = 4.6A. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Davamatar		Cumbal	Test Conditions	LX8585/85A			Units
Parameter		Symbol	lest collations	Min.	Тур.	Max.	Oilits
Reference Voltage L	X8585/85A	V <sub>R</sub>	I <sub>o</sub> = 10mA, T <sub>A</sub> = 25°C	1.238	1.250	1.262	٧
			$10\text{mA} \le I_{O} \le 4.6\text{A}, 1.5\text{V} \le (V_{IN} - V_{O}), V_{IN} \le 7\text{V}, P \le P_{MAX}$	1.225	1.250	1.275	V
Line Regulation (Note 2)		dV <sub>R</sub> (IN)	$I_0 = 10 \text{mA}, 1.5 \text{V} \le (V_{IN} - V_{OUT}), V_{IN} \le 7 \text{V}$	GN/CK.	0.035	0.2	%
Load Regulation (Note 2)		dV <sub>R</sub> (L)	$V_{IN} - V_{O} = 3V$ , $10mA \le I_{O} \le 4.6A$		0.1	0.5	%
Thermal Regulation		dVo(P)	T <sub>A</sub> = 25°C, 20ms pulse		0.01	0.02	%/W
Ripple Rejection (Note 3)			$V_0 = 3.3V$ , f =120Hz, $C_{OUT} = 100\mu f$ Tantalum, $V_{IN} = 5V$				
			$C_{ADJ} = 10\mu F$ , $T_A = 25^{\circ}C$ , $I_O = 4.6A$	60	83		dB
Adjust Pin Current		I <sub>ADJ</sub>		L 35	55	100	μA
Adjust Pin Current Change		$\Delta I_{ADJ}$	$10\text{mA} \le I_{O} \le 4.6\text{A}, 1.5\text{V} \le (V_{IN} - V_{O}), V_{IN} \le 7\text{V}$	Turnit.	0.2	5	μА
Dropout Voltage L	X8585A	ΔV	$\Delta V_{REF} = 1\%$ , $I_{o} = 4.6A$	SQU	1.1	1.2	V
L	X8585		$\Delta V_{REF} = 1\%$ , $I_{O} = 4.6A$	esent hi	1.2	1.4	٧
			$\Delta V_{REF} = 1\%$ , $I_O = 3A$	en en	1.1	1.3	٧
Minimum Load Current		I <sub>O(MIN)</sub>	$V_{IN} \le 7V$		2	10	mA
Maximum Output Current (Note 4)		I <sub>O(MAX)</sub>	$1.4V \le (V_{IN} - V_{OUT}), V_{IN} \le 7V$	4.6	6		А
Temperature Stability (Note 3)		d Vo(t)		1988 A	0.25		%
Long Term Stability (Note 3	3)	dVo(t)	T <sub>A</sub> = 125°C, 1000 hrs	1000	0.3	1	%
RMS Output Noise (% of V	(Note 3)	V <sub>O RMS</sub>	$T_A = 125^{\circ}C$ , $10Hz \le f \le 10kHz$		0.003		%

Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

These parameters, although guaranteed, are not tested in production.

Note 4. I<sub>O (MAX)</sub> is measured under the condition that V<sub>O</sub> is forced below its nominal value by 100mV.





## LX8586/8586A

6A LOW DROPOUT POSITIVE ADJUSTABLE REGULATOR

THE INFINITE POWER OF INNOVATION PRELIMINARY DATA SHEET

## DESCRIPTION

The LX8586/86A are low dropout three terminal adjustable regulators with a minimum of 6A output current. Pentium® and Power PC® applications requiring fast transient response are ideally suited for this product family. The LX8586A is guaranteed to have < 1.1V at 6A and the LX8586 < 1.3V at 6A dropout voltage, making them ideal to provide well-regulated outputs of 2.5V to 3.6V using a 5V input supply.

Current limit is trimmed above 6.1A to ensure adequate output current and controlled short-circuit current.

On-chip thermal limiting provides protection against any combination of overload that would create excessive junction temperatures.

The LX8586/86A are available in both through-hole versions of the industrystandard, 3-pin TO-220 and TO-247 power packages.

Along with the standard µP supply applications, the LX8586 is ideal for Pentium® Pro applications such as GTL+ terminators (see application below).

## **KEY FEATURES**

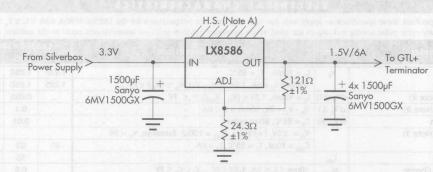
- GUARANTEED < 1.1V HEADROOM AT 6A (LX8586A)
- GUARANTEED < 1.3V HEADROOM AT 6A (LX8586)
- OUTPUT CURRENT OF 7A MINIMUM
- ☐ FAST TRANSIENT RESPONSE
- 1% VOLTAGE REFERENCE INITIAL ACCURACY
- □ OUTPUT SHORT CIRCUIT PROTECTION
- BUILT-IN THERMAL SHUTDOWN

## APPLICATIONS

- GTL+ BUS TERMINATORS
- PENTIUM SUPPLIES
- POWER PC SUPPLIES
- MICROPROCESSOR SUPPLIES
- LOW VOLTAGE LOGIC SUPPLIES
- POST REGULATOR FOR SWITCHING SUPPLY
- LXE9001 EVALUATION BOARD FOR PENTIUM APPLICATIONS AVAILABLE. **CONSULT FACTORY**

## PRODUCT HIGHLIGHT

1.5V, 6A REGULATOR



APPLICATION OF LX8586 AS 1.5V GTL+ BUS TERMINATOR

Note A: See application note, page 3.

P	ACKAGE	ORDER INFOR	MATION
T <sub>A</sub> (°C)	Dropout Voltage	P Plastic TO-220 3-pin	V Plastic TO-247 3-terminal
0 105	1.1V	LX8586-00CP	LX8586-00CV
0 to 125	1.3V	LX8586A-00CP	LX8586A-00CV

## THE ATA THE PRELIMINARY DATA SHEET

# Power Dissipation Internally Limited Input Voltage 10V Input to Output Voltage Differential 10V Operating Junction Temperature Plastic (P Package) 150°C Storage Temperature Range 65°C to 150°C Lead Temperature (Soldering, 10 seconds) 300°C Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

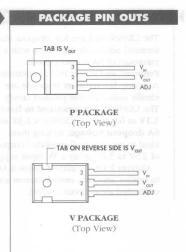
## THERMAL DATA

## P PACKAGE

F FACRAGE:	
THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{_{ m JT}}$	2.7°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{\mathrm{JA}}}$	60°C/W
V PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{_{ m JT}}$	1.6°C/W
THEDMAL DESISTANCE HINCTION TO AMBIENT A	35°C/W

Junction Temperature Calculation:  $T_j = T_A + (P_D \times \theta_{JA})$ . The  $\theta_{A}$  numbers are guidelines for the thermal performance of the device/pc-board system.

All of the above assume no ambient airflow.



## **ELECTRICAL CHARACTERISTICS**

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the LX8586/8586A with  $0^{\circ}$ C  $\leq$  T<sub>A</sub>  $\leq$  125°C; V<sub>IN</sub> - V<sub>O</sub> = 3V; I<sub>O</sub> = 6A. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter		Symbol	Test Conditions	LX	8586/858	36A	Units
Faidilletei		Sylliooi	lest conditions	Min.	ı. Typ.	Max.	
Reference Voltage	NTB1	V <sub>R</sub>	$I_0 = 10 \text{mA}, T_A = 25 ^{\circ}\text{C}$	1.238	1.250	1.262	٧
		+	$10\text{mA} \le I_{O} \le 6\text{A}, \ 1.5\text{V} \le (V_{IN} - V_{O}), \ V_{IN} \le 7\text{V}, \ P \le P_{MAX}$	1.225	1.250	1.275	٧
Line Regulation (Note 2)		dV <sub>R</sub> (IN)	$I_0 = 10 \text{mA}, 1.5 \text{V} \le (V_{IN} - V_{OUT}), V_{IN} \le 7 \text{V}$		0.035	0.2	%
Load Regulation (Note 2)	AUNDOLVAN	dV <sub>R</sub> (L)	$V_{IN} - V_{O} = 3V, 10 \text{mA} \le I_{O} \le 6A$		0.1	0.5	%
Thermal Regulation		dVo(P)	T <sub>A</sub> = 25°C, 20ms pulse		0.01	0.02	%/W
Ripple Rejection (Note 3)		No.	$V_{o} = 3.3V$ , f = 120Hz, $C_{out} = 100\mu f$ Tantalum, $V_{iN} = 5V$				
			$C_{ADJ} = 10 \mu F$ , $T_A = 25 °C$ , $I_O = 6 A$	60	83		dB
Adjust Pin Current		I <sub>ADJ</sub>			55	100	μА
Adjust Pin Current Change		$\Delta I_{ADJ}$	$10\text{mA} \le I_{O} \le 7\text{A}, 1.5\text{V} \le (V_{IN} - V_{O}), V_{IN} \le 7\text{V}$		0.2	5	μА
Dropout Voltage	LX8586A	ΔV	$\Delta V_{REF} = 1\%$ , $I_O = 6A$		0.9	1.1	٧
	LX8586		$\Delta V_{REF} = 1\%$ , $I_O = 6A$		1.1	1.3	V
Minimum Load Current		I <sub>O(MIN)</sub>	$V_{IN} \le 7V$		2	10	mA
Maximum Output Current (Note 4)		I <sub>O(MAX)</sub>	$1.4V \le (V_{IN} - V_{OUT}), V_{IN} \le 7V$	6.1	8		A
Temperature Stability		dVo(T)			0.25		%
Long Term Stability		$dV_{o}(t)$	T <sub>A</sub> = 125°C, 1000 hrs			1	%
RMS Output Noise (% of V	(0)	V <sub>O RMS</sub>	$T_A = 25^{\circ}C, 10Hz \le f \le 10kHz$	S100 2	0.003		%

Note 2. Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

Note 3. These parameters, although guaranteed, are not tested in production.

Note 4.  $I_{O\ (MAX)}$  is measured under the condition that  $V_O$  is forced below its nominal value by 100mV.



## PRELIMINARY DATA SHEET

## APPLICATION NOTES

The LX8586/86A is an easy to use Low-Dropout (LDO) voltage regulator. It has all of the standard self-protection features expected of a voltage regulator: short circuit protection, safe operating area protection and automatic thermal shutdown if the device temperature rises above approximately 165°C.

Use of an output capacitor is REQUIRED with the LX8586/86A. Please see the table below for recommended minimum capacitor values.

The regulator offers a more tightly controlled reference voltage tolerance and superior reference stability when measured against the older pin-compatible regulator types that it replaces.

## STABILITY

The output capacitor is part of the regulator's frequency compensation system. Many types of capacitors are available, with different capacitance value tolerances, capacitance temperature coefficients, and equivalent series impedances. For all operating conditions, connection of a 220µF aluminum electrolytic capacitor or a  $47\mu\mathrm{F}$  solid tantalum capacitor between the output terminal and ground will guarantee stable operation.

If a bypass capacitor is connected between the output voltage adjust (ADJ) pin and ground, ripple rejection will be improved (please see the section entitled "RIPPLE REJECTION"). When ADJ pin bypassing is used, the required output capacitor value increases. Output capacitor values of 220µF (aluminum) or 47µF (tantalum) provide for all cases of bypassing the ADJ pin. If an ADJ pin bypass capacitor is not used, smaller output capacitor values are adequate. The table below shows recommended minimum capacitance values for stable operation.

## **RECOMMENDED CAPACITOR VALUES**

INPUT	OUTPUT	ADJ
10µF	15pF Tantalum, 100pF Aluminum	None
10µF	47µF Tantalum, 220µF Aluminum	15pF

In order to ensure good transient response from the power supply system under rapidly changing current load conditions, designers generally use several output capacitors connected in parallel. Such an arrangement serves to minimize the effects of the parasitic resistance (ESR) and inductance (ESL) that are present in all capacitors. Cost-effective solutions that sufficiently limit ESR and ESL effects generally result in total capacitance values in the range of hundreds to thousands of microfarads, which is more than adequate to meet regulator output capacitor specifications. Output capacitance values may be increased without limit.

The circuit shown in Figure 1 can be used to observe the transient response characteristics of the regulator in a power system under changing loads. The effects of different capacitor types and values on transient response parameters, such as overshoot and undershoot, can be quickly compared in order to develop an optimum solution.

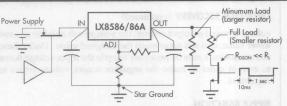


FIGURE 1 — DYNAMIC INPUT and OUTPUT TEST

## OVERLOAD RECOVERY

Like almost all IC power regulators, the LX8586/86A is equipped with Safe Operating Area (SOA) protection. The SOA circuit limits the regulator's maximum output current to progressively lower values as the input-to-output voltage difference increases. By limiting the maximum output current, the SOA circuit keeps the amount of power that is dissipated in the regulator itself within safe limits for all values of input-to-output voltage within the operating range of the regulator. The LX8586/86A SOA protection system is designed to be able to supply some output current for all values of input-to-output voltage, up to the device breakdown voltage.

Under some conditions, a correctly operating SOA circuit may prevent a power supply system from returning to regulated operation after removal of an intermittent short circuit at the output of the regulator. This is a normal mode of operation which can be seen in most similar products, including older devices such as 7800 series regulators. It is most likely to occur when the power system input voltage is relatively high and the load impedance is relatively low.

When the power system is started "cold", both the input and output voltages are very close to zero. The output voltage closely follows the rising input voltage, and the input-to-output voltage difference is small. The SOA circuit therefore permits the regulator to supply large amounts of current as needed to develop the designed voltage level at the regulator output. Now consider the case where the regulator is supplying regulated voltage to a resistive load under steady state conditions. A moderate input-to-output voltage appears across the regulator but the voltage difference is small enough that the SOA circuitry allows sufficient current to flow through the regulator to develop the designed output voltage across the load resistance. If the output resistor is short-circuited to ground, the input-to-output voltage difference across the regulator suddenly becomes larger by the amount of voltage that had appeared across the load resistor. The SOA circuit reads the increased input-tooutput voltage, and cuts back the amount of current that it will permit the regulator to supply to its output terminal. When the short circuit across the output resistor is removed, all the regulator output current will again flow through the output resistor. The maximum current that the regulator can supply to the resistor will be limited by the SOA circuit, based on the large input-to-output voltage across the regulator at the time the short circuit is removed from the output. If this limited current is not sufficient to develop the designed



## LX8586/8586A

## 6A LOW DROPOUT POSITIVE ADJUSTABLE REGULATOR

## PRELIMINARY DATA SHEET

## **APPLICATION NOTES**

## **OVERLOAD RECOVERY** (continued)

voltage across the output resistor, the voltage will stabilize at some lower value, and will never reach the designed value. Under these circumstances, it may be necessary to cycle the input voltage down to zero in order to make the regulator output voltage return to regulation.

## RIPPLE REJECTION

Ripple rejection can be improved by connecting a capacitor between the ADJ pin and ground. The value of the capacitor should be chosen so that the impedance of the capacitor is equal in magnitude to the resistance of R1 at the ripple frequency. The capacitor value can be determined by using this equation:

$$C = 1 / (6.28 * F_p * R1)$$

where:  $C \equiv \text{the value of the capacitor in Farads}$ ; select an equal or larger standard value.

 $F_{\nu} \equiv \text{the ripple frequency in Hz}$ R1 = the value of resistor R1 in ohms

At a ripple frequency of 120Hz, with R1 =  $100\Omega$ :

$$C = 1 / (6.28 * 120 Hz * 100 \Omega) = 13.3 uF$$

The closest equal or larger standard value should be used, in this case, 15µF.

When an ADJ pin bypass capacitor is used, output ripple amplitude will be essentially independent of the output voltage. If an ADJ pin bypass capacitor is not used, output ripple will be proportional to the ratio of the output voltage to the reference voltage:

$$M = V_{OUT}/V_{RFF}$$

where:  $M \equiv a$  multiplier for the ripple seen when the ADJ pin is optimally bypassed.  $V_{REF} = 1.25V.$ 

$$V_{--} = 1.25V$$

For example, if  $V_{OLT} = 2.5V$  the output ripple will be:

$$M = 2.5V/1.25V = 2$$

Output ripple will be twice as bad as it would be if the ADJ pin were to be bypassed to ground with a properly selected capacitor.

## **OUTPUT VOLTAGE**

The LX8586/86A develops a 1.25V reference voltage between the output and the adjust terminal (See Figure 2). By placing a resistor, R1, between these two terminals, a constant current is caused to flow through R1 and down through R2 to set the overall output voltage. Normally this current is the specified minimum load current of 10mA. Because I is very small and constant when compared with the current through R1, it represents a small error and can usually be ignored.

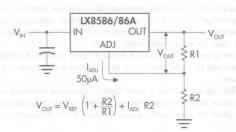


FIGURE 2 — BASIC ADJUSTABLE REGULATOR

## LOAD REGULATION

Because the LX8586/86A is a three-terminal device, it is not possible to provide true remote load sensing. Load regulation will be limited by the resistance of the wire connecting the regulator to the load. The data sheet specification for load regulation is measured at the bottom of the package. Negative side sensing is a true Kelvin connection, with the bottom of the output divider returned to the negative side of the load. Although it may not be immediately obvious, best load regulation is obtained when the top of the resistor divider, (R1), is connected directly to the case of the regulator, not to the load. This is illustrated in Figure 3. If R1 were connected to the load, the effective resistance between the regulator and the load would be:

$$R_{peff} = R_p * \left(\frac{R2+R1}{R1}\right)$$

where:  $R_p \equiv Actual parasitic line resistance.$ 

When the circuit is connected as shown in Figure 3, the parasitic resistance appears as its actual value, rather than the higher R

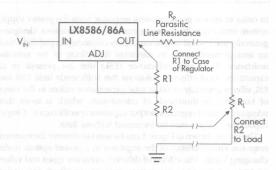


FIGURE 3 — CONNECTIONS FOR BEST LOAD REGULATION

## PRELIMINARY DATA SHEET

## **APPLICATION NOTES**

## LOAD REGULATION (continued)

Even when the circuit is optimally configured, parasitic resistance can be a significant source of error. A 100 mil wide PC trace built from 1 oz. copper-clad circuit board material has a parasitic resistance of about 5 milliohms per inch of its length at room temperature. If a 3-terminal regulator used to supply 2.50 volts is connected by 2 inches of this trace to a load which draws 5 amps of current, a 50 millivolt drop will appear between the regulator and the load. Even when the regulator output voltage is precisely 2.50 volts, the load will only see 2.45 volts, which is a 2% error. It is important to keep the connection between the regulator output pin and the load as short as possible, and to use wide traces or heavy-gauge wire.

The minimum specified output capacitance for the regulator should be located near the reglator package. If several capacitors are used in parallel to construct the power system output capacitance, any capacitors beyond the minimum needed to meet the specified requirements of the regulator should be located near the sections of the load that require rapidly-changing amounts of current. Placing capacitors near the sources of load transients will help ensure that power system transient response is not impaired by the effects of trace impedance.

To maintain good load regulation, wide traces should be used on the input side of the regulator, especially between the input capacitors and the regulator. Input capacitor ESR must be small enough that the voltage at the input pin does not drop below  $V_{\mbox{\tiny IN OMINO}}$  during transients.

$$V_{IN (MIN)} = V_{OUT} + V_{DROPOUT (MAX)}$$

where:  $V_{IN (MIN)}$  = the lowest allowable instantaneous voltage at the input pin.

V<sub>OUT</sub> ≡ the designed output voltage for the power supply system.

 $V_{DROPOUT (MAX)} \equiv$  the specified dropout voltage for the installed regulator.

## THERMAL CONSIDERATIONS

The LX8586/86A regulator has internal power and thermal limiting circuitry designed to protect the device under overload conditions. For continuous normal load conditions, however, maximum junction temperature ratings must not be exceeded. It is important to give careful consideration to all sources of thermal resistance from junction to ambient. This includes junction to case, case to heat sink interface, and heat sink thermal resistance itself.

Junction-to-case thermal resistance is specified from the IC junction to the back surface of the case directly opposite the die. This is the lowest resistance path for heat flow. Proper mounting is required to ensure the best possible thermal flow from this area of the package to the heat sink. Thermal compound at the case-to-heat-sink interface is strongly recommended. If the case of the device must be electrically isolated, a thermally conductive spacer

can be used, as long as its added contribution to thermal resistance is considered. Note that the case of all devices in this series is electrically connected to the output.

## Example

Given: 
$$V_{IN} = 5V$$
  
 $V_{O} = 2.8V$ ,  $I_{O} = 5.0A$   
Ambient Temp.,  $T_{A} = 50^{\circ}C$   
 $R_{BTT} = 2.7^{\circ}C/W$  for TO-220  
300 ft/min airflow available

Find: Proper Heat Sink to keep IC's junction temperature below 125°C.\*\*

Solution: The junction temperature is:

$$T_J = P_D (R_{\theta JT} + R_{\theta CS} + R_{\theta SA}) + T_A$$

where:  $P_D \equiv Dissipated power$ .

 $R_{\theta JT} \equiv$  Thermal resistance from the junction to the mounting tab of the package.

R<sub>BCS</sub> ≡ Thermal resistance through the interface between the IC and the surface on which it is mounted. (1.0°C/W at 6 in-lbs mounting screw torque.)

R<sub>85A</sub> ≡ Thermal resistance from the mounting surface to ambient (thermal resistance of the heat sink).

 $T_s \equiv \text{Heat sink temperature.}$ 

First, find the maximum allowable thermal resistance of the heat sink:

$$\begin{split} R_{_{\Theta SA}} &= \frac{T_{_{J}} - T_{_{A}}}{P_{_{D}}} - (R_{_{\theta JT}} + R_{_{\theta CS}}) \\ P_{_{D}} &= (V_{_{IN(MAN)}} - V_{_{O}}) I_{_{O}} &= (5.0V - 2.8V) * 5.0A \\ &= 11.0W \\ R_{_{\Theta SA}} &= \frac{125^{\circ}\text{C} - 50^{\circ}\text{C}}{(5.0V - 2.8V) * 5.0A} - (2.7^{\circ}\text{C/W} + 1.0^{\circ}\text{C/W}) \end{split}$$

Next, select a suitable heat sink. The selected heat sink must have  $R_{\rm BSA} \leq 3.1^{\circ} \text{C/W}$ . Thermalloy heatsink 6296B has  $R_{\rm BSA} = 3.0^{\circ} \text{C/W}$  with 300ft/min air flow.

Finally, verify that junction temperature remains within specification using the selected heat sink:

$$T_1 = 11W (2.7^{\circ}C/W + 1.0^{\circ}C/W + 3.0^{\circ}C/W) + 50^{\circ}C = 124^{\circ}C$$

\*\* Although the device can operate up to 150°C junction, it is recommended for long term reliability to keep the junction temperature below 125°C whenever possible.



## LX8586/8586A

## 6A LOW DROPOUT POSITIVE ADJUSTABLE REGULATOR

## PRELIMINARY DATA SHEET

## TYPICAL APPLICATIONS

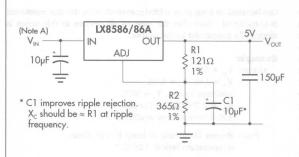
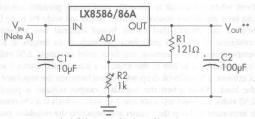


FIGURE 4 — IMPROVING RIPPLE REJECTION



\* Needed if device is far from filter capacitors.

FIGURE 5 — 1.2V - 8V ADJUSTABLE REGULATOR

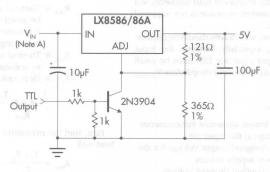


FIGURE 6 — 5V REGULATOR WITH SHUTDOWN

Note A:  $V_{IN (MIN)} = (Intended V_{OUT}) + (V_{DROPOUT (MAX)})$ 





## LX8587/8587A

## 3A LOW DROPOUT POSITIVE ADJUSTABLE REGULATOR

THE INFINITE POWER OF INNOVATION PRELIMINARY DATA SHEET

## DESCRIPTION

The LX8587/8587A are low dropout three terminal adjustable regulators with a minimum of 3A output current. Pentium® and Power PC® applications requiring fast transient response are ideally suited for this product family. The LX8587A is guaranteed to have < 1.2V dropout at 3A and the LX8587 < 1.3V at the same current, making them ideal to provide well-regulated outputs of 2.5V to 3.6V using a 5V input supply.

Current limit is trimmed above 3.1A to ensure adequate output current and controlled short-circuit current. Onchip thermal limiting provides protection against any combination of overload that would create excessive junction temperatures.

The LX8587/87A are available in both through-hole TO-220 as well as TO-263 surface-mount packages.

For higher current applications, see the LX8585 and LX8584 data sheets.

## KEY FEATURES

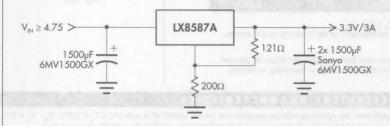
- GUARANTEED < 1.2V HEADROOM AT 3A (LX8587A)
- **■** GUARANTEED < 1.3V HEADROOM AT 3A (LX8587)
- OUTPUT CURRENT OF 3A MINIMUM
- FAST TRANSIENT RESPONSE
- 1% VOLTAGE REFERENCE INITIAL **ACCURACY**
- □ OUTPUT SHORT CIRCUIT PROTECTION
- BUILT-IN THERMAL SHUTDOWN

## APPLICATIONS

- PENTIUM SUPPLIES
- POWER PC SUPPLIES
- MICROPROCESSOR SUPPLIES
- LOW VOLTAGE LOGIC SUPPLIES
- POST REGULATOR FOR SWITCHING SUPPLY
- LXE9001 EVALUATION BOARD FOR PENTIUM APPLICATIONS AVAILABLE. CONSULT FACTORY.

## PRODUCT HIGHLIGHT

TYPICAL APPLICATION OF LX8587 IN A 5V TO 3.3V MOTHERBOARD APPLICATION



The output capacitors must be low ESR and low ESL type for good transient response.

## PACKAGE ORDER INFORMATION DD Plastic TO-263 Plastic TO-220 Dropout T (°C) Voltage 3-pin 3-pin 1.3V LX8587-00CP LX8587-00CDD 0 to 125 1.2V LX8587A-00CP LX8587A-00CDD

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX8587A-00CDDT)

## ATAC Y AMPRELIMINARY DATA SHEET

## Power Dissipation Internally Limited Input Voltage 10V Input to Output Voltage 10V Operating Junction Temperature Plastic (P Package) 150°C Storage Temperature Range -65°C to 150°C Lead Temperature (Soldering, 10 seconds) 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

## THERMAL DATA

## P PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{_{JT}}$	3.0°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{ m JA}}$	60°C/W
DD PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{_{JT}}$	3.0°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	60°C/W*

Junction Temperature Calculation:  $T_J = T_A + (P_D \times \theta_{JA})$ .

The  $\theta_{j_1}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

\* With package soldered to 0.5 in.² copper area over back-side ground plane or internal power plane,  $\theta_{\rm ia}$  can vary from 20°C/W to 40°C/W, depending on mounting technique.

# TAB IS Vour P PACKAGE (Top View) TAB IS Vour TOP View)

## **ELECTRICAL CHARACTERISTICS**

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the LX8587/87A with  $0^{\circ}\text{C} \leq \text{T}_{\text{A}} \leq 125^{\circ}\text{C}$ ;  $\text{V}_{\text{IN}} - \text{V}_{\text{O}} = 3\text{V}$ ;  $\text{I}_{\text{O}} = 3\text{A}$ . Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX	8587/858	37A	Units
raiailletei	Symool	lest Conditions	Min.	Тур.	Max.	Units
Reference Voltage	V <sub>R</sub>	$I_{o} = 10 \text{mA}, T_{A} = 25 ^{\circ}\text{C}$	1.238	1.250	1.262	V
		$10\text{mA} \le I_{O} \le 3\text{A}, \ 1.5\text{V} \le (V_{IN} - V_{O}), \ V_{IN} \le 7\text{V}, \ P \le P_{MAX}$	1.225	1.250	1.275	٧
Line Regulation (Note 2)	d V <sub>R</sub> (IN)	$I_{o} = 10 \text{mA}, 1.5 \text{V} \le (V_{iN} - V_{out}), V_{iN} \le 7 \text{V}$		0.035	0.2	%
Load Regulation (Note 2)	dV <sub>R</sub> (L)	$V_{IN} - V_{O} = 3V, 10mA \le I_{O} \le 3A$		0.1	0.5	%
Thermal Regulation	d V <sub>o</sub> (P)	T <sub>A</sub> = 25°C, 20ms pulse		0.01	0.02	%/W
Ripple Rejection (Note 3)		$V_{\odot} = 3.3V$ , f =120Hz, $C_{OUT} = 100\mu f$ Tantalum, $V_{IN} = 5V$				
		$C_{ADJ} = 10 \mu F$ , $T_A = 25 ° C$ , $I_O = 3 A$	60	83		dB
Adjust Pin Current	I <sub>ADJ</sub>			55	100	μА
Adjust Pin Current Change	$\Delta I_{ADJ}$	$10\text{mA} \le I_{O} \le 3\text{A}, \ 1.5\text{V} \le (V_{IN} - V_{O}), \ V_{IN} \le 7\text{V}$		0.2	5	μA
Dropout Voltage	ΔV	$\Delta V_{REF} = 1\%$ , $I_{O} = 3A$ (LX8587A)		1	1.2	٧
		$\Delta V_{REF} = 1\%$ , $I_{O} = 3A$ (LX8587)		1.1	1.3	V
Minimum Load Current	I <sub>O(MIN)</sub>	$V_{IN} \leq 7V$		2	10	mA
Maximum Output Current (Note 4)	I <sub>O(MAX)</sub>	$1.4V \le (V_{IN} - V_{OUT}), V_{IN} \le 7V$	3.1	5		Α
Temperature Stability	dVo(T)	A M R D Y AL DE SIDE OF A AD ARTHUR		0.25		%
Long Term Stability	dVo(t)	T <sub>A</sub> = 125°C, 1000 hrs			1	%
RMS Output Noise (% of Vo)	V <sub>O RMS</sub>	$T_A = 25$ °C, $10Hz \le f \le 10kHz$		0.003		%

Note 2. Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

Note 3. These parameters, although guaranteed, are not tested in production.

Note 4.  $I_{O(MAX)}$  is measured under the condition that  $V_{O}$  is forced below its nominal value by 100mV.

C LINFINITY

MICROELECTRONICS





5 V LOW DROPOUT REGULATOR

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

## DESCRIPTION

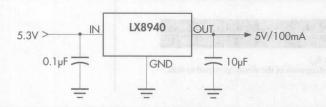
The LX8940 is a 5V, low dropout, low quiescent current regulator rated for 1A of output current. It can regulate with as low as 0.4V headroom between the input and output voltages, thus minimizing power dissipation. In addition, it can be used in applications where worst case supplies require a

low input-output differential to maintain regulation. This feature makes it ideal for computer monitors that have to comply with energy-efficient / "Green PC" programs, where the input voltage drops to only a few tenths of a volt above the output when power supply enters sleep-mode operation.

## KEY FEATURES

- 2% INTERNALLY TRIMMED OUTPUT
- OUTPUT CURRENT IN EXCESS OF 1A
- INPUT-OUTPUT DIFFERENTIAL LESS THAN 0.4V AT 1A
- REVERSE BATTERY PROTECTION
- 60V LOAD DUMP PROTECTION
- □ -50V REVERSE TRANSIENT PROTECTION
- SHORT CIRCUIT PROTECTION
- INTERNAL THERMAL OVERLOAD **PROTECTION**
- AVAILABLE IN 3-LEAD PLASTIC TO-220
- ☐ DROPS IN MOST LM2940 SOCKETS

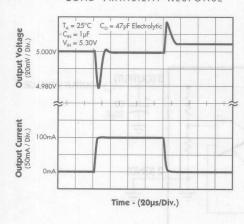
## PRODUCT HIGHLIGHT



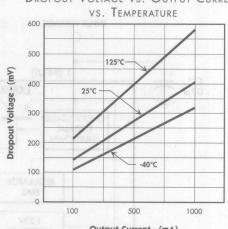
## APPLICATIONS

- SMALL HEADROOM BATTERY APPLICATIONS
- HIGH EFFICIENCY LINEAR REGULATORS
- POST REGULATORS FOR SWITCHING POWER SUPPLIES
- GREEN PC MONITOR APPLICATIONS

## LOAD TRANSIENT RESPONSE



## DROPOUT VOLTAGE VS. OUTPUT CURRENT



## Output Current - (mA)

## PACKAGE ORDER INFO

T <sub>A</sub> (°C)	P Plastic TO-220 3-pin
0 to 125	LX8940CP
-40 to 125	LX8940IP

## 5 V LOW DROPOUT REGULATOR

## TRANS ANA UNIT PRODUCTION DATA SHEET

## 

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal. Pin numbers refer to DIL packages only.

## Tab is GROUND Tab is GROUND OUTPUT GND INPUT P PACKAGE (Top View)

## THERMAL DATA

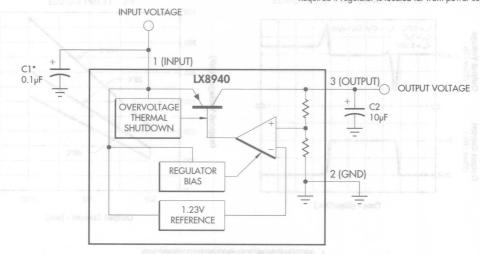
## P PACKAGE:

THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{ m JT}$	3.0°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	60°C/W

Junction Temperature Calculation:  $T_j = T_A + (P_D \times \theta_{jA})$ . The  $\theta_{jA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

## BLOCK DIAGRAM

\* Required if regulator is located far from power supply filter.





μF

## 5 V LOW DROPOUT REGULATOR

## PRODUCTION DATA SHEET

## RECOMMENDED OPERATING CONDITIONS **Recommended Operating Conditions** Symbol Units **Parameter** Min. V Input Voltage VIN Note 2 Load Current (with adequate heatsinking) 5 1000 Maximum Line Transient (Load Dump), $V_o \le 5.5V$ V Input Capacitor (V<sub>IN</sub> to GND) 0.1 μF

Output Capacitor with ESR of  $10\Omega$  max., ( $V_{OUT}$  to GND &  $V_{SB}$  to GND) Note 2.  $V_{IN (DMIN)} = 1.2 \Delta V_{(MAX)}$ . See Dropout Voltage maximum limit.

## **ELECTRICAL CHARACTERISTICS**

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Unless otherwise specified, these specifications apply over the operating ambient temperatures of -40°C to +125°C for LX8940IP, and 0°C to +125°C for LX8940CP;  $V_{\rm IN}$  = 10V,  $I_{\rm O}$  = 1A,  $I_{\rm OUT}$  = 22µF, and are for DC characteristics only. (Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX8940		Units	
raidilletei	Syllidol	Test conditions	Min.	Тур.	Max.	Units
Output Voltage	Vo	$I_0 = 0A$ , $T_A = 25$ °C	4.85	5	5.15	V
Line Regulation	ΔV <sub>OI</sub>	$7V \le V_{IN} \le 26V$ , $I_{O} = 5mA$		10	50	mV
Load Regulation	$\Delta V_{OL}$	50mA ≤ I <sub>o</sub> ≤ 1A	versy box	10	50	mV
Output Impedance (Note 3)	ro	$100\text{mA}_{DC}$ and $20\text{mA}_{RMS}$ , $f_O = 120\text{Hz}$	N SIE N	200	tamen	mΩ
Quiescent Current	l <sub>a</sub>	$I_{o} \le 5 \text{mA}, 7 \le V_{iN} \le 26 \text{V}$	o leman	3	15	mA
whetively guards against overheiting of the		I <sub>o</sub> = 500mA	"Viewlit"	30	50	mA
	nt exempl	I <sub>o</sub> = 1000mA	duror-8s	115	180	mA
Output Noise Voltage (Note 3)	V <sub>O RMS</sub>	10Hz - 100kHz, I <sub>o</sub> = 5mA	3 (150)	150	H ROHE	µV <sub>RMS</sub>
Long Term Stability (Note 3)				20		mV/1000h
Ripple Rejection (Note 3)	R <sub>R</sub>	$f_0 = 120$ Hz, $1V_{RMS}$ , $I_0 = 100$ mA		66		dB
Dropout Voltage	ΔV	I <sub>o</sub> = 100mA		150	300	mV
I <sub>o</sub> =		I <sub>o</sub> = 500mA		275	500	mV
		I <sub>o</sub> = 1A		400	800	mV
Current Limit	Ict	$V_{IN} = 26V$	1	1.2	1156	А
Maximum Operational Input Voltage	V <sub>IN (MAX)</sub>		26	31		٧
Maximum Line Transient	V <sub>IN (TR)</sub>	$R_{o} = 100\Omega$ , T $\leq 100$ ms		60		٧

Note 3. These parameters, although guaranteed, are not tested in production.

## 5 V LOW DROPOUT REGULATOR

## PRODUCTION DATA SHEET

## APPLICATION NOTES

The advantages of using a low-dropout regulator such as the LX8940 is the need for less "headroom" for full regulation, and the inherent reverse polarity protection provided by the PNP output device. A typical NPN regulator design requires an input to output differential of approximately two volts minimum. This is due to the 2Vbe + Vcesat of the NPN Darlington used in the output, coupled with the voltage drop across the current limit resistor. In contrast, the "PNP Regulator" uses a single series pass transistor with its single Vcesat, thus the lower input to output voltage differential or dropout voltage.

In some applications the regulator output voltage is used not only as a power supply but also as a voltage reference for control systems. In such cases not just the temperature stability of the output is important but also the initial accuracy. LX8940 fills this need as the internal bandgap reference is trimmed allowing a typical output voltage tolerance of ±1%.

## **EXTERNAL CAPACITORS**

To stabilize the outputs and prevent oscillation (perhaps by many volts) external capacitors are required. The minimum recommended value for the output capacitors is  $10\mu F$ , although the actual size and type will likely vary according to the particular application, e.g., operating temperature range and load. Another consideration is the effective series resistance (ESR) of the

capacitor. Capacitor ESR will vary by manufacturer. Consequently, some evaluation may be required to determine the minimum value of the output capacitors. Generally worst case occurs at the maximum load and minimum ambient temperature.

The size of the output capacitor can be increased to any value above the minimum. One possible advantage of this would be to maintain the output voltage during brief periods of negative input transients.

The output capacitors chosen should be rated for the full range of ambient temperature over which the circuit will be exposed and expected to operate. For example, many aluminum type electrolytic capacitors change values at cold temperatures. The effective capacitance is reduced and regulator stability is effected. Tantalum capacitors are a good choice for these types of environments.

## **OUTPUT PROTECTION**

The output features fault protection against overvoltage as well as a thermal shutdown feature. If the input voltage rises above 33V (load dump), the output shuts down automatically. The internal circuitry is thus protected and the IC is able to survive higher voltage transients than might otherwise be expected. The thermal shutdown output effectively guards against overheating of the die and protects the device from being damaged.







ADJUSTABLE LOW DROPOUT REGULATOR

THE INFINITE POWER OF INNOVATIONAL PRELIMINARY DATA SHEET

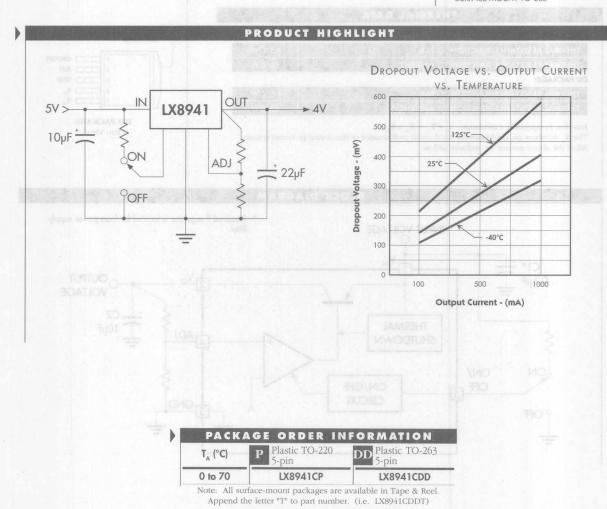
## DESCRIPTION

The LX8941 is an adjustable, low dropout regulator rated for more than 1A of output current. It can regulate with as low as 0.6V headroom between the input and output voltages, at 1A output current, thus minimizing power dissipation. In addition, it can be used in applications where worst case supplies require a low input-output

differential to maintain regulation. This feature makes it ideal for some processor applications that require 4V operation from a 5V supply. In addition, the LX8941 provides an on/off switch that reduces the IC quiescent current when activated, making it ideal for battery operated applications.

## **KEY FEATURES**

- 2% INTERNALLY TRIMMED OUTPUT
- OUTPUT CURRENT IN EXCESS OF 1A
- INPUT-OUTPUT DIFFERENTIAL LESS THAN 0.6V AT 1A
- REVERSE BATTERY PROTECTION
- SHORT CIRCUIT PROTECTION
- INTERNAL THERMAL OVERLOAD PROTECTION
- ☐ AVAILABLE IN 5-LEAD PLASTIC TO-220 AND SURFACE MOUNT TO-263



## ADJUSTABLE LOW DROPOUT REGULATOR

## THERE ATAC YEAR PRELIMINARY DATA SHEET

## ABSOLUTE MAXIMUM RATINGS (Note 1)

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

## 

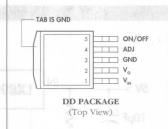
## THERMAL DATA

## PPACKAGE

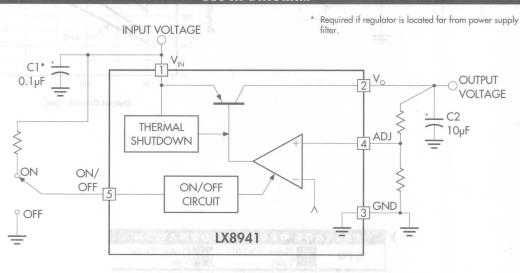
FFACIAGE.	
THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{_{\mathrm{JT}}}$	4.5°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	60°C/W
DD PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{_{\mathrm{JT}}}$	4.5°C/W
THERMAL DESISTANCE, ILINCTION TO AMBIENT A	60°C/W

Junction Temperature Calculation:  $T_r = T_A + (P_D \times \theta_{IA})$ .

The  $\theta_{J_A}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.



## BLOCK DIAGRAM





## ADJUSTABLE LOW DROPOUT REGULATOR

## PRELIMINARY DATA SHEET

## RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Recommended Operating Conditions			Units
Parameter	Syllidoi	Min.	Тур.	Max.	Oilles
Input Voltage	V <sub>IN</sub>	Note 2		24	V
Load Current (with adequate heatsinking)		5		1000	mA
Input Capacitor (V <sub>IN</sub> to GND)		0.1			μF
Output Capacitor with ESR of 10Ω max., (V <sub>our</sub> to GND)		10			μF

Note 2.  $V_{IN\,(MIN)} = 1.2\Delta V_{(MAX)}$ . See Dropout Voltage maximum limit.

## **ELECTRICAL CHARACTERISTICS**

Unless otherwise specified, these specifications apply over the operating ambient temperature of 0°C to +125°C for LX8941CP;  $V_{IN}$  = 10V,  $I_{O}$  = 1A,  $C_{OUT}$  = 22 $\mu$ F, and are for DC characteristics only. (Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	LX8941		Units	
Faranteter	Sylliooi	rest conditions	Min.	Тур.	Max.	Oilits
ADJ Pin Voltage	Vo	I <sub>O</sub> = 0A, T <sub>A</sub> = 25°C	1.231	1.27	1.308	٧
Line Regulation	ΔV <sub>OI</sub>	$V_{o} + 2V \le V_{iN} \le 26V, I_{o} = 5mA$		10	50	mV
Load Regulation	$\Delta V_{OL}$	50mA ≤ I <sub>o</sub> ≤ 1A		10	50	mV
Dropout Voltage	ΔV	I <sub>o</sub> = 100mA		150	300	mV
		I <sub>o</sub> = 500mA		275	500	mV
		I <sub>o</sub> = 1A	,	400	800	mV
Quiescent Current	I <sub>o</sub>	$I_{o} \le 5 \text{mA}, 7 \le V_{iN} \le 26 V$		3	15	mA
		I <sub>o</sub> = 500mA	2000	30	50	mA
		I <sub>o</sub> = 1000mA		115	180	mA
Current Limit	Icı	V <sub>IN</sub> = 26V	1	1.2		Α
Output Noise Voltage (Note 3)	V <sub>O RMS</sub>	10Hz - 100kHz, I <sub>o</sub> = 5mA		150		μV <sub>RMS</sub>
Long Term Stability (Note 3)				20		mV/1000h
Ripple Rejection (Note 3)	R <sub>R</sub>	$f_0 = 120$ Hz, $1V_{RMS}$ , $I_0 = 100$ mA		66		dB
Enable Logic Section				1977		
On Threshold Voltage			2			٧
On Threshold Current					50	μА
Off Threshold Voltage					0.8	٧
Off Threshold Current			-10	100		μA

Note 3. These parameters, although guaranteed, are not tested in production.



## Notes

## TRIAZ ATAB PRESIMENTAL

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Note 4. These committee although magnificed, as not reised as production





## LXM1590/LXM1591

CUSTOMIZABLE CCFL INVERTER MODULES

THE INFINITE POWER OF INNOVATION

PRELIMINARY DATA SHEET

## DESCRIPTION

LXM1590 series CCFL (cold cathode fluorescent lamp) Inverter Modules are specifically designed for driving LCD back light lamps in portable computers where dimmability, ultrahigh efficiency, low noise emissions, reliable fail safe design, and small form factors are critical parameters. Mechanical form factors and electrical characteristics can be customized for volume applications. Both monochrome and color displays with either one or two lamps are supported.

The modules convert unregulated DC voltage from the system battery or AC adapter directly to high-frequency, highvoltage sine waves required to ignite and operate CCFL lamps. The module design is based on a proprietary Linfinity IC that provides important new performance advances.

Remarkable improvements in efficiency and RF emissions result from its single stage resonant inverter featuring a patent pending Current Synchronous, Zero Voltage Switching (CS-ZVS) topology. CS-ZVS produces nearly pure sine wave currents in the lamp enabling maximum light delivery while reducing both conducted and radiated noise. This topology simultaneously performs

three tasks consisting of line voltage regulation, lamp current regulation, and lamp dimming in a single power stage made up of one or two pairs of low loss FET's. The FET's drive an LC resonant circuit that feeds the primary of a high voltage transformer with a sinusoidal voltage.

Required L and C values in the resonant circuit are such that very low loss components can be used to obtain higher electrical efficiency than is possible with previous topologies.

Two module versions are available. The half bridge LXM1590 provides peak efficiency when operated with less than 2 watt lamps at input voltages above 6 volts. The LXM1591 achieves higher efficiency at higher output power levels and lower input voltages with its full bridge drive circuit.

The modules are equipped with a dimming input that permits full range brightness control from an external potentiometer, and a sleep input that reduces module power to a few microwatts in shut down

All modules feature output open and short circuit protection.

## KEY FEATURES

- 35% MORE LIGHT OUTPUT AT 2.5 WATTS
- CLOSED LOOP, FULLY REGULATING DESIGN
- 4.5V TO 30V INPUT VOLTAGE RANGES
- VERSATILE BRIGHTNESS CONTROL INPUT
- 3 MICROAMP SLEEP CURRENT
- OUTPUT SHORT CIRCUIT PROTECTION AND AUTOMATIC OVER VOLTAGE LIMITING
- 8mm MAX HEIGHT, NARROW FOOTPRINTS
- SINGLE SIDED PCB IS SELF INSULATING

## APPLICATIONS

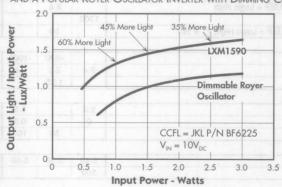
- NOTEBOOK AND SUB-NOTEBOOK COMPLITERS
- PERSONAL DIGITAL ASSISTANTS
- PORTABLE INSTRUMENTATION
- ALITOMOTIVE DISPLAYS
- DESKTOP DISPLAYS
- AIRLINE ENTERTAINMENT CENTERS

## BENEFITS

- ULTRA-HIGH EFFICIENCY, LINE VOLTAGE REGULATION AND SLEEP MODE EXTEND COMPUTER BATTERY LIFE
- COOL OPERATION PERMITS CLOSE PROXIMITY TO LCD PANEL WITHOUT DISPLAY DISTORTION
- SMOOTH, FULL-RANGE BRIGHTNESS CONTROL GIVES YOUR PRODUCT A HIGH QUALITY IMAGE
- LOW EMI / RFI DESIGN MINIMIZES SHIELDING REQUIREMENTS
- NARROW, LOW PROFILE STANDARD MODULES FIT INTO MOST LCD **ENCLOSURES**
- SINGLE SIDED PCB SAVES EXPENSIVE HIGH **VOLTAGE INSULATING TAPES**

## PRODUCT HIGHLIGHT

MEASURED LIGHT OUTPUT VS. POWER INPUT FOR LXM1590 AND A POPULAR ROYER OSCILLATOR INVERTER WITH DIMMING CONTROL



## MODULE ORDER INFORMATION

HALF BRIDGE DRIVE FULL BRIDGE DRIVE LXM1590-xxxxx-zz LXM1591-xxxxx-zz

See instructions inside for completing module part number.

# CUSTOMIZABLE CCFL INVERTER MODULES

# THE ATA THE PRELIMINARY DATA SHEET

ABSOLUTE MAXIMU	N RATINGS (Note 1)
Input Supply Voltage $(V_{IN})$	Internally Limited to 1900V
Output Voltage, 10 load Output Current Output Power Input Signal Voltage, (SLEEP and BRITE Inputs) Ambient Operating Temperature, zero airflow Storage Temperature Range	8.0mA <sub>RMS</sub> (Internally Limited)
Input Signal Voltage. (SLEEP and BRITE Inputs)	4.2W
Ambient Operating Temperature, zero airflow	0°C to 60°C
Storage Temperature Range	-40°C to 85°C
Note 1. Exceeding these ratings could cause damage to the device. All voltage	es are with respect to Ground. Currents are positive into, negative out of

# RECOMMENDED OPERATING CONDITIONS (R.C.)

This module has been designed to operate over a wide range of input and output conditions. However, best efficiency and performance will be obtained if the module is operated under the condition listed in the 'R.C.' column. Min. and Max. columns indicate values beyond which the inverter, although operational, will not function optimally.

Parameter		Symbol	Recomme	Units		
Parameter		Symool	Min.	R.C.	Max.	Ullits
Input Supply Voltage	LXM1590	V <sub>IN</sub>	7	12	30	V
	LXM1591	or served milite	4.5	A LIMB OF A PURIOR	6.5	٧
Output Power	- 111 AND ARMIN I	Po	ma mil s	2.5	4.0	W
Brightness Control Input Voltage Range	and a decree foreign	V <sub>BRITE</sub>	0.8		2.5	٧
Lamp Operating Voltage	Till sense beinte.	V <sub>LAMP</sub>	240	500	650	V <sub>RMS</sub>
Lamp Current - Full Brightness	-matricular limite	IOLAMP	C. 1251	5	7 199	mA <sub>RMS</sub>
Operating Ambient Temperature Range	at reduces module	TA THE TANK	0	or EVX-ED vacil	60	°C

# ELECTRICAL CHARACTERISTICS

Unless otherwise specified, these specifications apply over the recommended operating conditions and 25°C ambient temperature for the LXM1590/1591.

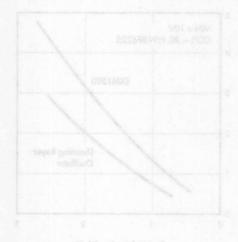
Parameter Symbol		Test Conditions	LX/	A1590/1	591	Units
Falanietei	Sylliooi	rest collations	Min.	Тур.	Max.	Onit
Output Pin Characteristics		vs. Power larger for UXM1.590				
Full Bright Lamp Current	I <sub>L (MAX)</sub>	$V_{BRITE} = 2.5 V_{DC}$ , SLEEP = Logic High	6.2	6.6	7.0	mA
Minimum Lamp Current	I <sub>L (MIN)</sub>	V <sub>BRITE</sub> = 0.9 V <sub>DC</sub> , SLEEP = Logic High		2.6		mA <sub>RM</sub>
Lamp Start Voltage	V <sub>LS</sub>	0°C < T <sub>A</sub> < 60°C	1300			V <sub>RMS</sub>
Operating Frequency	fo	$V_{BRITE} = 2.5V_{DC}$ , $\overline{SLEEP} = Logic High, V_{IN} = 12V$	LINSIM STR	50	- 46	KHz
Brightness Control		(A)22/23/2	More Light	408	8	
Input Current	IBRITE	$V_{BRITE} = OV_{DC}$	The same of the sa	-200	-1000	nA <sub>DC</sub>
Input Voltage for Max. Lamp Current	V <sub>c</sub>	I <sub>O (LAMP)</sub> = 100%	2.4	2.5	2.6	V <sub>DC</sub>
Input Voltage for 50% Lamp Current	V <sub>c</sub>	$I_{O(LAMP)} = 50\%$		1.25	3.5	V <sub>DC</sub>
SLEEP Input		Osodlotor			E 13	
Input Logic 1	V <sub>IH</sub>		2.2		5.5	V <sub>DC</sub>
Input Logc 0	V <sub>IL</sub>		0	181	0.8	V <sub>DC</sub>
Input Current	I	$V_{\overline{\text{SLEEP}}} = 0 - 5V_{DC}$		50	100	μA <sub>DC</sub>
Voltage Reference		_v01 = _v			Ö	
Output Voltage	V <sub>REF</sub>	$0 < I_{REF} < 500 \mu A$	2.40	2.50	2.60	V <sub>DC</sub>
Output Current	I <sub>REF</sub>	1004 U.S. C.A. 165 U.S.	500	100		μA <sub>DC</sub>
Power Characteristics		是是1964年 - 19 9000g	70 QUI			
Sleep Current	I <sub>IN (MIN)</sub>	$V_{IN} = 5V_{DC}$ , $\overline{SLEEP} = Logic 0$	N (British	3	10	μA <sub>DC</sub>
Electrical Efficiency (calculated values)		LXM1590, $V_{IN} = 12V_{DC}$ , $I_{O(LAMP)} = 5mA_{RMS}$	1 2 1	92		%
	40,000	LXM1591, $V_{IN} = 5V_{DC}$ , $I_{O(LAMP)} = 5mA_{RMS}$		90		%

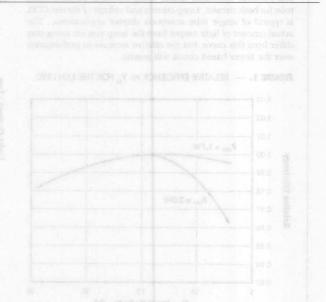


# CUSTOMIZABLE CCFL INVERTER MODULES

# PRELIMINARY DATA SHEET

		FUNCTIONAL	PIN DESCRIPTION
Conn.	Pin	Description	
CN1	and don't	AV VALOR WAS THE THE DESIGNATION	COOL second second and many in the second and the second and second
CN1-1 CN1-2	V <sub>IN</sub>	Input voltage. (+7 to $+30V_{DC}$ )	
CN1-3 CN1-4	GND	Power supply return.	
CN1-5	SLEEP	the lamp. A floating input is sense	verter operation. Logical low removes power from the module and d as a logical low and will disable inverter operation. If not used, istor to $V_{\rm IN}$ or directly to any voltage between 2.5 and 7V. May be
CN1-6	BRITE		to 2.5 volts DC to control lamp brightness. Lamp current varies circuit or 2.5V gives maximum brightness.
CN1-7	AGND	Brightness control signal return. For	best results do not run $\boldsymbol{V}_{\hspace{-0.05cm}\text{\tiny IN}}$ power supply current return through this pin.
CN1-8	V <sub>REF</sub>	Reference Voltage Output. 2.5V @	500µA max. For use with external dimming circuit.
CN2		The state of the s	portable commuters. Figures I and 2 below characterize relative
CN2-1	LAMP HI	High voltage connection to high sic connect to ground.	le of lamp. Connect to lamp terminal with shortest lead length. Do not
CN2-2	LAMP LO	High voltage connection to low sic connect to ground.	e of lamp. Connect to lamp terminal with longer lead length. Do not





# CUSTOMIZABLE CCFL INVERTER MODULES

PRELIMINARY DATA SHEET

#### CCFL INVERTER EFFICIENCY - THE EVOLUTION CONTINUES

Portable computing is dependent on low power flat panel LCD display technology. Each new shrinking of computer size and weight has resulted in exponential market growth. New LCD's with richer color now promise yet another order of magnitude growth in notebook sized machines. Great looking color displays need lots of light, more than monochrome displays. The power to generate that light must come from the system battery. But the battery cannot grow in size and weight, so the conversion from battery power to visible light must be made more efficient.

The LXM1590/1591 modules are the latest evolution in inverter technology and represent the most efficient method yet, generating 35% to 60% more light from a CCFL tube than today's most popular solutions1. Present technologies are based on the venerable Royer oscillator circuit enhanced with various types of voltage regulator circuits that permit operation from an unregulated battery input and enable the dimming function needed in portable computers. Figures 1 and 2 below characterize relative efficiency over a broad range of input voltage and at typical one and two lamp CCFL output power levels. Figure 3 compares actual light outputs of the LXM1591 module at various battery power levels with a popular dimmable Royer oscillator based solution. The data in Figure 3 was measured in a specially built and carefully calibrated fixture using the same physical CCFL tube for both circuits. Lamp current and voltage of the test CCFL is typical of single tube notebook display applications. The actual amount of light output from the lamp you are using may differ from this curve, but the relative increase in performance over the Royer based circuit will remain.

FIGURE 1. — RELATIVE EFFICIENCY vs. V<sub>IN</sub> FOR THE LXM1590

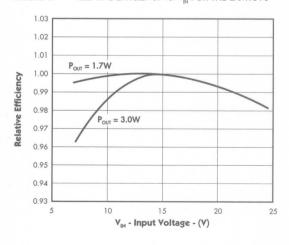


FIGURE 2. — RELATIVE EFFICIENCY VS. VIN FOR THE LXM1591

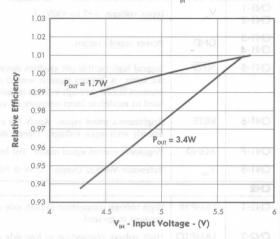
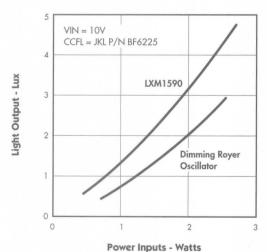


FIGURE 3. — LIGHT OUTPUT vs. POWER INPUT



Note: 1 Lux = 1 Lm/ $m^2$  = 1 Lumen/meter<sup>2</sup> = 10.76 foot candles.

<sup>&</sup>lt;sup>1</sup> See "A New and Improved Control Technique Greatly Simplifies The Design Of Highly Efficient Dimming CCFL Backlight Inverter Circuits". *Natbant, LMI, 1994* 



# CUSTOMIZABLE CCFL INVERTER MODULES

# PRELIMINARY DATA SHEET

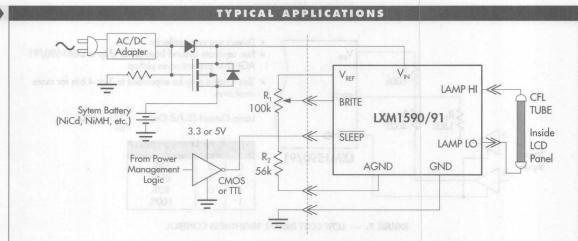


FIGURE 4. — NOTEBOOK SYSTEM APPLICATION

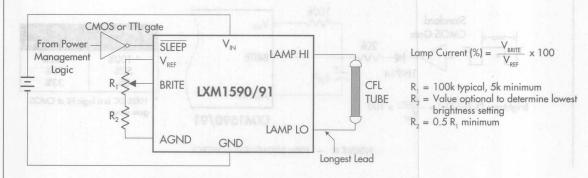


FIGURE 5. — POTENTIOMETER BRIGHTNESS CONTROL & SLEEP MODE

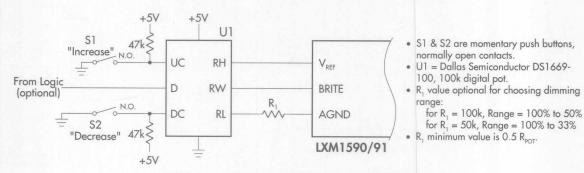
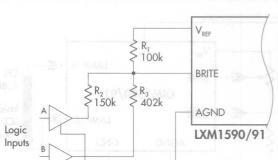


FIGURE 6. — NON-VOLATILE DIGITAL BRIGHTNESS CONTROL



## TYPICAL APPLICATIONS (continued)

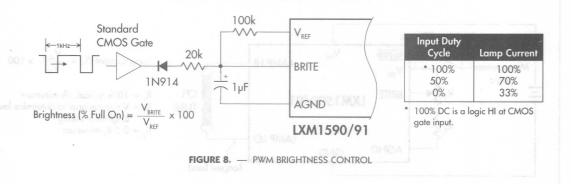


- · Drivers are open collector.
- Run separate ground from driver chip to LXM1590/91 AGND to prevent noise pickup.
- This scheme may be expanded to 3 or 4 bits for more resolution.

$$Lamp Current (\% Full On) = \frac{V_{BRITE}}{V_{REF}} \times 100$$

Α	В	Lamp Current
0	0	52%
0	1	60%
1	0	80%
1	1	100%

FIGURE 7. — LOW COST DIGITAL BRIGHTNESS CONTROL



# CUSTOMIZABLE CCFL INVERTER MODULES

# PRELIMINARY DATA SHEET

## COMPLETING THE MODULE PART NUMBER

- 1. Choose either the half or full bridge version by comparing your operating conditions and efficiency needs to the efficiency curves in Figures 1 & 2.
- 2. Choose the nominal input voltage you will be using, that is, the voltage where you want efficiency to be highest. Selections are in 1.2V increments to match the 1.2V/cell potential of NiCd and NiMH batteries. If a different type of power source is being used, select the closest nominal voltage.
- 3. Choose the minimum input voltage where full lamp brightness is needed. For convenience, selections are in 0.9V increments, corresponding to end of discharge potential for NiCd and NiMH cells. Your selection need not correspond to the number of cells selected for nominal voltage input.
- 4. Specify lamp running voltage.
- 5. Specify maximum lamp start voltage.
- 6. Specify lamp running current.
- 7. Choose over temperature option. (See "Over Temperature Protection Option" Section on Page 3 for complete description of this option.)
- 8. Choose mechanical configuration (-zz) from the specific mechanical data sheets below.

dule Type  = Half Bridge Drive (7.0V to 30V Ba	tteny Voltage	
= Full Bridge Drive (4.5V to 6.5V Ba		101.01
minal Input Voltage (4 thru 11 NiM	H cells)	
$\begin{array}{llllllllllllllllllllllllllllllllllll$	9 = RSVD * 0 = RSVD *	(21.68)
nimum Input Voltage	0 (3.18) Dismeter Hole, 2 places	Compactat CN-1
$ = 4.5  V_{DC}  = 5.4  V_{DC}  = 6.3  V_{DC}  = 7.2  V_{DC} $ $ 5 = 8.1  V_{DC}  6 = 9.0  V_{DC}  7 = 9.9  V_{DC}  8 = 10.8  V_{DC} $	9 = RSVD * 0 = RSVD *	- 3 5 Auct. (8)
minal Lamp Operating Voltage		
$\begin{array}{llllllllllllllllllllllllllllllllllll$	$0 = RSVD^*$	Ali dimensions in inches (mos)
ximum Lamp Start Voltage	- MOLEX 53261-08	LWD
$\begin{array}{llllllllllllllllllllllllllllllllllll$	$7 = 1200 \text{ V}_{\text{RMS}}$ $8 = 1300 \text{ V}_{\text{RMS}}$ $9 = 1400 \text{ V}_{\text{RMS}}$	CN-2
minal Lamp Operating Current at F	ull Brightness	
$\begin{array}{llllllllllllllllllllllllllllllllllll$	0 = RSVD *	CNI-1 = V <sub>rs</sub> CNI-2 = V <sub>rs</sub>
served		$CNI-3 = V_{cc}$

Mechanical Configuration

See following Specific Data Sheets

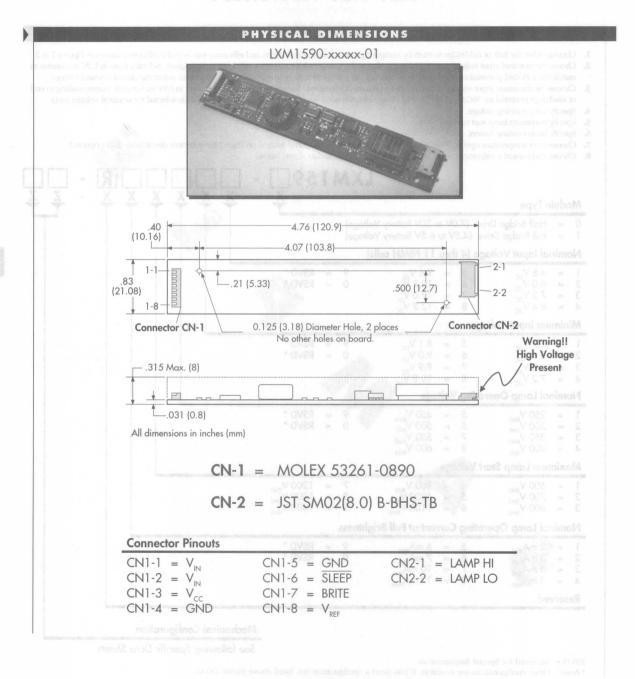
RSVD = Reserved for Special Requirements

\* Note: Other configurations are available. If you need a configuration not listed above please call us.



# CUSTOMIZABLE CCFL INVERTER MODULES

PRELIMINARY DATA SHEET





Present

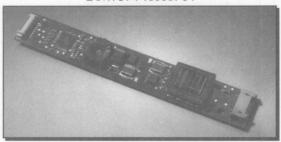
# LXM1590/LXM1591

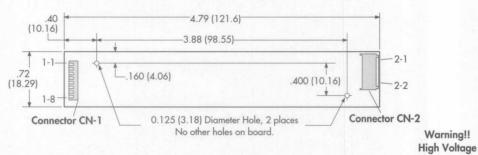
# CUSTOMIZABLE CCFL INVERTER MODULES

# PRELIMINARY DATA SHEET

# PHYSICAL DIMENSIONS

LXM1591-xxxxx-01







All dimensions in inches (mm)

CN-1 = MOLEX 53261-0890

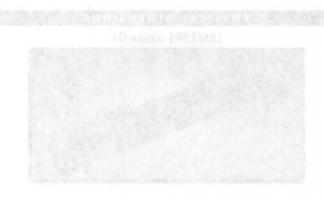
CN-2 = JST SMO2(8.0) B-BHS-TB

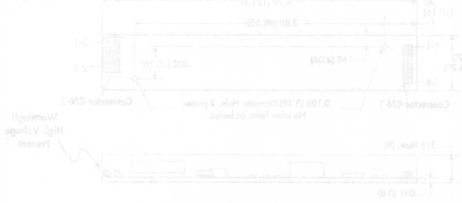
# **Connector Pinouts**

$CN1-1 = V_{IN}$	CN1-5 = SLEEP	CN2-1 = LAMP HI
$CN1-2 = V_{IN}$	CN1-6 = BRITE	CN2-2 = LAMPLO
CN1-3 = GND	CN1-7 = AGND	
CN1-4 = GND	$CN1-8 = V_{DEE}$	

# Notes

TILLS STAN VERNINIES STATE





An dimensions in inches (mm)

CN-1 = MOLEX 53261-0890

CN-2 = JST SMO2(8,0) B-BHS-TB





THE INFINITE POWER OF INNOVATION

# LXM1592/LXM1593

FLOATING OUTPUT DRIVE, CUSTOMIZABLE CCFL INVERTER MODULES

PRELIMINARY DATA SHEET

## DESCRIPTION

The LXM1592/93 series of floating output drive CCFL (Cold Cathode Fluorescent Lamp) Inverter Modules are specifically designed to drive large LCD displays (11.3" and larger), which are used in notebook computers. These new inverters were specifically designed to reduce the leakage currents from the lamp to the reflector or the metal frame of the panels. The floating output architecture of these inverters also permits a much wider dimming range when compared to nonfloating designs, and an additional 10% efficiency improvement is realized.

Both the LXM1592 and LXM1593 are fully customizable (electronically and mechanically) to specific customer require-

The modules convert unregulated DC voltage from the system battery or AC adapter directly to high-frequency, highvoltage sine waves required to ignite and operate CCFL lamps. The module design is based on a proprietary Linfinity IC that provides important new performance advances.

Remarkable improvements in efficiency and RF emissions result from these single stage resonant inverters, featuring a patent pending Current Synchronous, Zero Voltage Switching (CS-ZVS) topology. CS-ZVS produces nearly pure sine wave currents in the lamp, enabling maximum light delivery, while reducing both conducted and radiated noise. This topology simultaneously performs two tasks including line voltage regulation and lamp dimming through lamp current regulation. These two functions are performed in a single power stage made up of a pair of lowloss MOSFETs. The MOSFETs drive a low current resonant circuit that feeds the primary of a high voltage transformer with a sinusoidal voltage.

Required L and C values in the resonant circuit are such that very low-loss components can be used to obtain higher electrical efficiency than is possible with previous topologies.

Two module versions are available. The half-bridge LXM1592 provides peak efficiency when operated at input voltages above 7 volts. The LXM1593 achieves higher efficiency at input voltages above 4.5V with its full-bridge drive

The modules are equipped with a dimming input that permits full range brightness control from an external potentiometer, and a sleep input that reduces module power to a few microwatts in shut-down mode.

Each module features output open and short circuit protection.

#### **KEY FEATURES**

- FULLY FLOATING OUTPUT
- 35% MORE LIGHT OUTPUT AT 2.5 WATTS
- GREATER EFFICIENCY THAN GROUNDED **OUTPUT DESIGNS**
- 4.5V TO 30V INPUT VOLTAGE RANGES
- VERSATILE BRIGHTNESS CONTROL INPUT
- 3 MICROAMP SLEEP CURRENT
- OUTPUT SHORT CIRCUIT PROTECTION AND AUTOMATIC OVER VOLTAGE LIMITING
- 8mm MAX HEIGHT, NARROW FOOTPRINTS
- MINIMIZE THERMOMETER EFFECTS
- MINIMIZE LAMP TO PANEL LEAKAGE CURRENT

## APPLICATIONS

- 11.3" LCD PANELS AND LARGER
- NOTEBOOK AND SUB-NOTEBOOK COMPUTERS
- PERSONAL DIGITAL ASSISTANTS
- **PORTABLE INSTRUMENTATION**
- **■** AUTOMOTIVE DISPLAYS
- **■** DESKTOP DISPLAYS
- AIRLINE ENTERTAINMENT CENTERS

#### BENEFITS

- **III** ULTRA-HIGH EFFICIENCY, LINE VOLTAGE REGULATION AND SLEEP MODE EXTEND COMPUTER BATTERY LIFE
- COOL OPERATION PERMITS CLOSE PROXIMITY TO LCD PANEL WITHOUT DISPLAY DISTORTION
- SMOOTH, FULL-RANGE BRIGHTNESS CONTROL GIVES YOUR PRODUCT A HIGH QUALITY IMAGE
- LOW EMI / RFI DESIGN MINIMIZES SHIELDING REQUIREMENTS
- NARROW, LOW-PROFILE STANDARD MODULES FIT INTO MOST LCD **ENCLOSURES**
- SINGLE-SIDED PCB SAVES EXPENSIVE HIGH VOLTAGE INSULATING TAPES

# High Voltage Transformer SYZ-SZ nverte DC VIN H

PRODUCT HIGHLIGHT

FLOATING OUTPUT ARCHITECTURE

# MODULE ORDER INFORMATION

HALF-BRIDGE DRIVE **FULL-BRIDGE DRIVE** LXM1592-xxxxx-zz LXM1593-xxxxxx-zz

See instructions inside for completing module part number.

FOR FURTHER INFORMATION CALL (714) 898-8121

# FLOATING OUTPUT DRIVE, CUSTOMIZABLE CCFL INVERTER MODULES

# PRELIMINARY DATA SHEET

ABSOLUTE MAXIMU	M RATINGS (Note 1)
Input Supply Voltage (V <sub>IN</sub> ) Output Voltage, no load Output Current Output Power Input Signal Voltage, (SLEEP and BRITE Inputs)	Internally Limited to 1700V
Input Signal Voltage, (SLEEP and BRITE Inputs)  Ambient Operating Temperature, zero airflow  Storage Temperature Range	-0.3V to 6.5V .0°C to 60°C -40°C to 85°C
Note 1. Exceeding these ratings could cause damage to the device. All volta	ges are with respect to Ground. Currents are positive into, negative out of

# RECOMMENDED OPERATING CONDITIONS (R.C.)

This module has been designed to operate over a wide range of input and output conditions. However, best efficiency and performance will be obtained if the module is operated under the condition listed in the 'R.C.' column. Min. and Max. columns indicate values beyond which the inverter, although operational, will not function optimally.

Payamotay		Cumbal	Recomm	Conditions	Units	
Parameter		Symbol	Min.	R.C.	Max.	Oilits
Input Supply Voltage	LXM1592	V <sub>IN</sub>	Chem 7 -	12	30	V
	LXM1593	neav alubom	4.5		6.5	V
Output Power	stead southout za	Po	THE PARTY	2.5	4.2	W
Brightness Control Input Voltage Range	ENSTRUMENT AND	V <sub>BRITE</sub>	0.8	also the greatest three	2.5	V
Lamp Operating Voltage	A STATE OF THE STA	V <sub>LAMP</sub>	240	500	650	V <sub>RMS</sub>
Lamp Current - Full Brightness	white backer drive	IOLAMP	Micague -	5	6.5	mA <sub>RMS</sub>
Operating Ambient Temperature Range		T <sub>A</sub>	0	albinidai I saussiss	60	°C

## **ELECTRICAL CHARACTERISTICS**

Parameter	Symbol		Test Conditions			A1592/1		Unit
	-/				Min.	Тур.	Max.	
Output Pin Characteristics								
Full Bright Lamp Current	I <sub>L (MAX)</sub>	$V_{BRITE} = 2.5 V_{DC} \overline{SLEEP}$	= Logic High		5.9	6.2	6.5	mA
Minimum Lamp Current	I <sub>L (MIN)</sub>	V <sub>BRITE</sub> = 0.8 V <sub>DC</sub> , SLEEP	= Logic High			2.0	a in the second	mA <sub>RA</sub>
Lamp Start Voltage	V <sub>LS</sub>	0°C < T <sub>A</sub> < 60°C			1200	Mary Jan		VRMS
Operating Frequency	fo	V <sub>BRITE</sub> = 2.5V <sub>DC</sub> , SLEEP =	Logic High, V <sub>IN</sub> = 12V	Charles	uers (A	70		KHz
Brightness Control								
Input Current	I <sub>BRITE</sub>	$V_{BRITE} = OV_{DC}$				-200	-1000	nA <sub>D</sub>
Input Voltage for Max. Lamp Current	V <sub>c</sub>	I <sub>O (LAMP)</sub> = 100%	appliev hein		2.4	2.5	2.6	V <sub>DC</sub>
Input Voltage for 50% Lamp Current	V <sub>c</sub>	I <sub>O (LAMP)</sub> = 50%	irgnsignmer			1.25		V <sub>DC</sub>
SLEEP Input			211	ed.	cu L			
Input Logic 1	V <sub>IH</sub>	37	3110	19.	2.2		5.5	V <sub>DC</sub>
Input Logc 0	V <sub>IL</sub>	10	3116		0	M	0.8	V <sub>DC</sub>
Input Current	In	$V_{\overline{SLEEP}} = 0 - 5V_{DC}$	NII.	3	1	50	100	μA <sub>D</sub>
Voltage Reference								
Output Voltage	V <sub>REF</sub>	0 < I <sub>REF</sub> < 500μA		-	2.40	2.50	2.60	V <sub>DC</sub>
Output Current	IREF				500			μA <sub>D</sub>
Power Characteristics								
Sleep Current	I <sub>IN (MIN)</sub>	$V_{IN} = 5V_{DC}$ , $\overline{SLEEP} = LC$	ogic 0			3	10	μA <sub>D</sub>
Electrical Efficiency (calculated values)		LXM1592, VIN = 12VDC	$I_{O(LAMP)} = 5mA_{RMS}$	B 4		92		%
	TVISICI	LXM1593, V <sub>IN</sub> = 5V <sub>DC</sub> , I				90		%



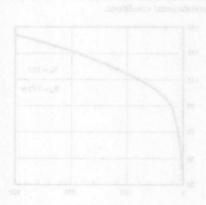
mance data will be presented comparing conflicating versus

must first be determined before thy nutaningful measurements

# FLOATING OUTPUT DRIVE, CUSTOMIZABLE CCFL INVERTER MODULES

# PRELIMINARY DATA SHEET

		FUNCTIONAL PIN DESCRIPTION	
Conn.	Pin	Description	
CN1		MODUCTION CONTRACTOR OF THE PROPERTY OF THE PR	124
CN1-1 CN1-2	V <sub>IN</sub>	Input voltage. (+4.5 to +30V <sub>DC</sub> )	
CN1-3 CN1-4	GND	Power supply return.	
CN1-5	SLEEP	Logical high on this pin enables inverter operation. Logical low removes power from the module the lamp. A floating input is sensed as a logical low and will disable inverter operation. If not us connect $\overline{\text{SLEEP}}$ through a 33k $\Omega$ resistor to $V_{\text{IN}}$ or directly to any voltage between 2.5 and 5.5V.	
CN1-6	BRITE	Brightness control input. Apply 0.9 to 2.5 volts DC to control lamp brightness. Lamp current var linearly with input voltage. Open circuit or 2.5V gives maximum brightness.	
CN1-7	AGND	Brightness control signal return. For best results do not run $V_{1N}$ power supply current return through	this pin.
CN1-8	V <sub>REF</sub>	Reference Voltage Output. 2.5V @ 500μA max. For use with external dimming circuit.	
CN2		The discussion which tollow will send execute against can be used.  Server to the GCPL send executive trial data wintly can be used.	aliei eris
CN2-1	LAMP HI	High-voltage connection to high side of lamp. Connect to lamp terminal with shortest lead length connect to ground.	. Do not
CN2-2	LAMP LO	High-voltage connection to low side of lamp. Connect to lamp terminal with longer lead length. connect to ground.	



PROBURE 2 - INITIAL TURN-ON CHARACTERISTICS O

**LINFINITY**MICROFILECTRONICS

# FLOATING OUTPUT DRIVE, CUSTOMIZABLE CCFL INVERTER MODULES

## PRELIMINARY DATA SHEET

## TECHNICAL / ANALYSIS INFORMATION

## INTRODUCTION

This section discusses some general topics in testing and evaluating Cold Cathode Fluorescent Lamps (CCFL) along with the inverters that drive them as they are used in active and passive matrix LCD displays. In particular, this discussion will concentrate on the testing of the Current Synchronous Zero Voltage Switching Inverter.

The past two years have seen a rapid change in the types of available LCD displays, as well as their lighting and inverter systems.

Significant strides have been made in the light transmission efficiencies of the optical systems in addition to efficiency gains in their lighting and inverter systems. At the same time, some of these improvements, especially in the reflector and lamp housing systems, now pose difficulties when driving these lamps.

The discussion which follows will examine lighting characteristics of the CCFL's and experimental data which can be used to determine the duration of time that it takes for the light output from the CCFL to stabilize. In addition, light output efficiency calculation methods will be presented that can help sort out various efficiency claims from different inverter manufacturers.

As part of the following discussion, the parasitics of the CCFL/Panel system will be modeled and SPICE simulations will reveal the current profile in the lamp. Finally, actual performance data will be presented comparing non-floating versus floating secondaries, with an analysis of this data.

#### LIGHTING CHARACTERISTICS OF CCFLs

The duration of time that it takes for the light output to stabilize must first be determined before any meaningful measurements can be made. This is important when trying to maintain consistency between measurements, and is also important in minimizing the required testing time.

Several factors affect the light output of the CCFL's, such as operating current waveshape and frequency, proximity of the lamp to conducting surfaces, inverter output configuration, and ambient temperature, among other things. In addition, the newer lamps have very small diameters and operate at higher gas pressures. It appears that this makes these lamps electrically more unstable.

In order to determine the time required to reach steady state for a particular lighting system in this test, a completely automated data acquisition system has been set up that is capable of taking light output data at uniform time intervals. The power supply, the ammeter and voltmeter are all controlled by the computer. The photometer's RS-232 port is connected to the RS-232 port of the computer. Figure 1 shows a block diagram of this setup.

With this setup, the calculation of the power input and efficiencies is greatly simplified, because automation and data gathering consistency are assured.

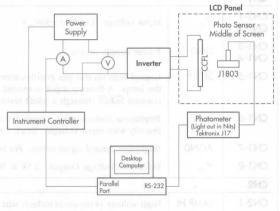


FIGURE 1 — MEASUREMENT SETUP

100 samples are taken from a system at 3 second intervals consisting of the following:

- 1. Lamp type: 560Vrms Operating at 5-6mA.
- Inverter type: Half-bridge floating output CS-ZVS inverter at 10V input.
- 3. Lamp is housed in a 11.3" active matrix LCD panel.
- 4. The panel is laid flat on a desk with the photometer placed at the center of the panel.

The result of these measurements is shown in Figure 2. This figure shows the initial turn-on profile of the lamp under specific environmental conditions.

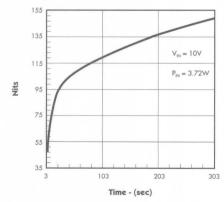


FIGURE 2 — INITIAL TURN-ON CHARACTERISTICS OF THE CCFL IN A HIGH-EFFICIENCY 11.3" LCD PANEL



# FLOATING OUTPUT DRIVE, CUSTOMIZABLE CCFL INVERTER MODULES

## PRELIMINARY DATA SHEET

## TECHNICAL / ANALYSIS INFORMATION (continued

#### LIGHTING CHARACTERISTICS OF CCFLs (continued)

The rapid increase of light output during the first few seconds of this test is due to the fact that mercury vapor inside the CCFL reaching steady state concentration. The continual increase of light output from the lamp at a slower rate is a result of the thermal time constants of the system. Essentially, as the lamp gets warmer, it tends to become more efficient.

Figure 3 shows the light output efficiency of the system as calculated by using the following formula.

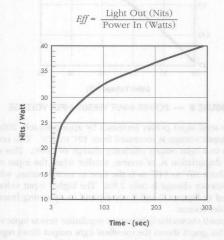


FIGURE 3 — LIGHT OUTPUT EFFICIENCY PROFILE DURING INITIAL TURN ON

Figure 3 clearly shows the increase in efficiency as the lamp in the panel is self heating. This graph also shows that 303 seconds is not a sufficient amount of time for this system to reach a steady state. Figure 5 shows what the required amount of time is for this system to reach a steady state.

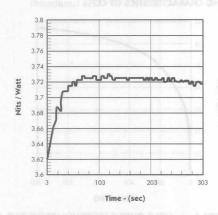


FIGURE 4 — INVERTER POWER INPUT PROFILE
DURING INITIAL TURN ON

Figure 4 shows the inverter power input profile during initial turn on. It is interesting to note that, when the inverter is first turned on, the input power is lower. This is a result of the higher impedance of the lamp. It takes a finite amount of time for the mercury to fully vaporize, thereby reducing the impedance of the lamp and permitting it to reach a steady state in terms of power.

Figures 5 and 6 show the above-mentioned system at a slightly different input power taken at a different time than the previous graphs. The light output and efficiency data is probably different because of a different ambient temperature. The sampling interval for these graphs was set at 10 seconds.

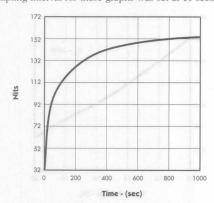


FIGURE 5 — LIGHT OUTPUT VERSUS TIME AT INITIAL TURN ON, 10sec SAMPLING PERIOD



FLOATING OUTPUT DRIVE, CUSTOMIZABLE CCFL INVERTER MODULES

PRELIMINARY DATA SHEET

#### TECHNICAL / ANALYSIS INFORMATION (continued)

#### LIGHTING CHARACTERISTICS OF CCFLs (continued)

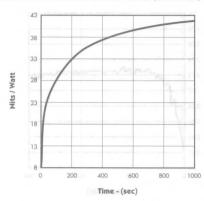


FIGURE 6 — LIGHT OUTPUT EFFICIENCY VERSUS TIME AT INITIAL TURN ON, 10sec SAMPLING PERIOD

Based on the graphs of Figures 5 and 6, it can be determined that this system reaches steady state in approximately 17 minutes.

#### **INVERTER INPUT VOLTAGE CONSIDERATIONS**

Almost all power conversion devices lose some efficiency when operated at voltages beyond their nominal values. In order to investigate the effect of input voltage variation on the light output efficiency, the input voltage to the inverter has been varied from its minimum to its maximum operating condition. The results of this effort are shown in Figures 7 and 8.

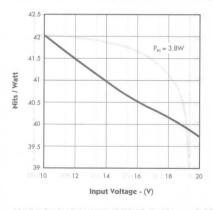


FIGURE 7 — LIGHT OUTPUT EFFICIENCY VERSUS INPUT VOLTAGE

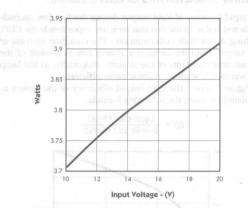


FIGURE 8 — POWER INPUT VERSUS INPUT VOLTAGE

The total input power increases by approximately 200mW when input voltage is increased from 10V to 20V. This corresponds to a light output efficiency change of 5.8%. This efficiency degradation is, of course, smaller when the input voltage is from 10V to 14V, as is the case in most systems, where the efficiency change is only 2.8%. The higher input voltages depicted in Figures 7 and 8 correspond to operating from an AC power source.

Figure 9 shows the light output regulation versus input voltage. This graph shows the excellent light output (line) regulation characteristic of a CS-ZVS inverter with the floating output. The total line regulation is only ±0.23% because of this the purity of the lamp drive current as well as the true load current sensing capability of this circuit.

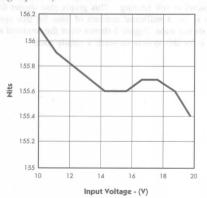


FIGURE 9 — LIGHT OUTPUT VERSUS INPUT VOLTAGE LIGHT OUTPUT REGULATION



# FLOATING OUTPUT DRIVE, CUSTOMIZABLE CCFL INVERTER MODULES

## PRELIMINARY DATA SHEET

#### TECHNICAL / ANALYSIS INFORMATION (continued)

#### **INVERTER INPUT VOLTAGE CONSIDERATIONS** (continued)

All the information discussed thus far can be very useful when trying to design the power subsystem. The minimal decrease in efficiency of the CS-ZVS inverter enables the system designer to have a relatively wide operating input voltage range without a significant efficiency penalty.

The inverter is normally designed for the minimum battery voltage. Efficiency is optimized when the minimum operating voltage is as close as possible to the nominal operating voltage.

#### A FEW WORDS ON NEW LCD PANEL DISPLAYS

Significant efficiency improvements have been made to the optical systems of newer, larger LCD panels, panels that are typically 11.3" inches and larger. However, these improvements, including improvements in the lightpipe, the reflector and the CCFL itself, have caused increased leakage currents from the lamp to the reflector and/or panel's metal frame. This condition results in degraded light output and reduced dimming ranges, when used with backlight inverters equipped with nonfloating (or grounded) high voltage sides. Further compounding the leakage current problem is an increase of the operating voltages of CCFL's, with some lamps requiring as high as 650V<sub>RMS</sub> to operate.

In a non-floating or grounded inverter, the output of the high-voltage transformer is referenced to ground, permitting leakage currents to circulate between the panel, the system ground and the inverter ground. In order to address these leakage currents, a new inverter configuration has been designed by Linfinity, which uses a floating output drive, coupled with Linfinity's patent pending CS-ZVS technology.

Generally speaking, in a floating output drive, the high-voltage side of the inverter transformer is not referenced to ground and, therefore, interrupts the path of the leakage currents, preventing them from flowing into the system ground. Because the Linfinity LXM1592 and LXM1593 are configured with a unique

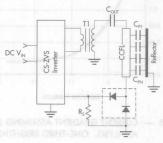


FIGURE 10 — NON-FLOATING OUTPUT CONFIGURATION.

C<sub>P1</sub> THROUGH C<sub>PN</sub> REPRESENT DISCRETIZED
DISTRIBUTED PARASITIC CAPACITANCE

combination of Linfinity's floating output architecture and CS-ZVS technique, they significantly reduce the leakage currents from the lamp to the reflector of the metal frame of the panel, further improving the efficiency of these newer inverters over non-floating, or grounded designs. The LXM1592 and LXM1593, equipped with the Linfinity floating output drive architecture, yield an additional 10% improvement in light output and also permit a wider dimming range, resulting in a more uniformly-lighted, as well as more efficient and brighter panel. Linfinity's floating output drive scheme, which currently is the only design which senses the secondary side lamp current, achieves very accurate lamp current regulation and, as such, is unique and superior even to other floating output implementations.

#### SIMPLIFIED MODELING OF THE CCFL-PANEL SYSTEM

#### Non-Floating Configuration

Figure 10 shows the electrical configuration of a non-floating drive. In this system, the CCFL current is being sensed with a resistor referenced to the inverter ground. The panel, along with the reflector, is also electrically "tied" to the inverter ground.

A "thermometer effect" (or brightness gradient) is created when the parasitic capacitance and the reflector are diverting useful current from the lamp to ground. This effect is very intense in some of the newer panels because the reflector is metal or metal-coated plastic or is situated very close to the panel itself. An additional side effect of this leakage is a marked reduction of efficiency.

The following experiment was performed in order to quantify this capacitance. A lamp was broken at both cathode ends and an AWG#18 bus wire was inserted through the tube. This assembly was then placed in the cavity of a metal reflector and the capacitance was measured using a standard RLC bridge. The measured parasitic capacitance was approximately 15pF. Normally this capacitance is distributed along the length of the tube. Also, the lamp wiring formed a parasitic capacitance with the metal frame, which in this case was about 14pF.

With the above information, a simple discrete distributed electrical model was constructed to help analyze the system. This electrical model of the non-floating configuration is shown in Figure 11.

The parasitic shunt capacitors shown as  $C_{\rm Pl}$ - $C_{\rm PN}$  produce a current gradient across the length of the lamp that results in the "thermometer effect" that exhibits itself as a brightness gradient. In extreme cases, this exhibits itself as partial lighting of the lamp with the "hot" side of the lamp being the brightest.

# FLOATING OUTPUT DRIVE, CUSTOMIZABLE CCFL INVERTER MODULES

## PRELIMINARY DATA SHEET

## TECHNICAL / ANALYSIS INFORMATION (continued)

#### SIMPLIFIED MODELING OF THE CCFL-PANEL SYSTEM (con't.)

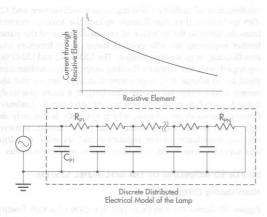


FIGURE 11 — NON-FLOATING OUTPUT CONFIGURATION.

ELECTRICAL MODEL OF LAMP THAT SHOWS

THE CURRENT PROFILE AS A RESULT OF THE

PARASITIC SHUNT CAPACITANCE

In order to study the effects of the parasitic capacitance, the lamp was divided into 20 identical segments, consisting of both resistive and capacitive elements. Assuming a full brightness operating impedance of  $100 \kappa \Omega$ , each individual resistive element would be  $5 \kappa \Omega$  and each capacitance would be 0.75 pE. The circuit then was solved by using a circuit simulator, such as SPICE. The capacitance of the wiring in the non-floating drive was inconsequential and was ignored. The accuracy of the above model is thought to be limited because of the nonlinear nature of the lamp impedance along the lamp length as a result of the thermometer effect (resulting in impedance modulation).

Figure 12 shows the result of SPICE simulation on the 20 element model. Impedance was adjusted for 600V and 6mA operation. This graph shows the variation of the current flow in the resistive elements of the lamp that produces light output. Furthermore, it shows that the current is higher at the "hot" end of the lamp by 2.4%. The effect of this is minimal light non-uniformity from one end of the lamp to the other. This is also apparent in the real circuit.

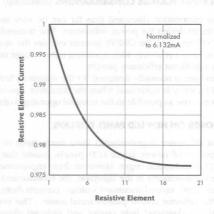


FIGURE 12 — CURRENT GRADIENT ASSUMING 20 ELEMENT ANALYSIS. FULL BRIGHTNESS

Figure 13 shows the result of SPICE simulation on the above 20 element model when the lamp is dimmed to 1/3 brightness. Impedance was adjusted in this case for 600V and 2mA operation. The current differential in this case was 20%. The consequence of this is that the brightness change from one end of the lamp to the other will likely be more than 25%, a variance which is clearly visible to the human eye.

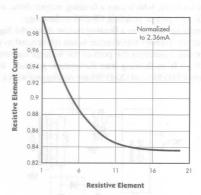


FIGURE 13 — CURRENT GRADIENT ASSUMING 20 ELEMENT ANALYSIS. ONE-THIRD BRIGHTNESS LEVEL

# FLOATING OUTPUT DRIVE, CUSTOMIZABLE CCFL INVERTER MODULES

## PRELIMINARY DATA SHEET

## TECHNICAL / ANALYSIS INFORMATION (continued)

#### SIMPLIFIED MODELING OF THE CCFL-PANEL SYSTEM (con't.)

Figure 14 shows the electrical configuration of a floating drive. In this system, the CCFL current is being sensed either in the primary side of the high-voltage transformer or at the secondary side. The panel and the reflector are electrically connected to the primary side (of T1) inverter ground.

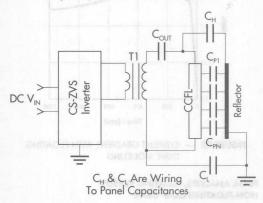


FIGURE 14 — FLOATING OUTPUT CONFIGURATION

Figure 16 shows the result of SPICE simulation on the circuit of Figure 15, again with a 20-element model.

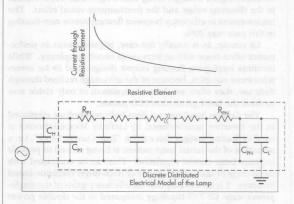


FIGURE 15 — FLOATING OUTPUT CONFIGURATION ELECTRICAL MODEL OF LAMP

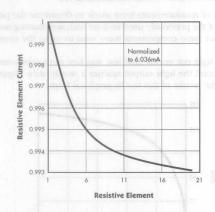


FIGURE 16 — CURRENT GRADIENT WITH FLOATING DRIVE MODELING

The total current deviation in this case is 0.7%. Although this a small deviation, it is expected that in a real physical circuit, the difference would be higher as a result of other unmodelled parasitics and lamp non-linearities.

Figure 17 shows the simulation results for the dimmed case of the floating drive. The total current deviation in this case is 6.1%. Thus, the floating drive introduces a smaller brightness gradient than the non-floating drive, resulting in a more uniformly lighted panel.

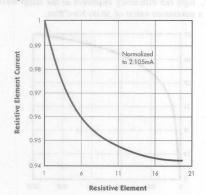


FIGURE 17 — CURRENT GRADIENT WITH FLOATING DRIVE MODELING

# FLOATING OUTPUT DRIVE, CUSTOMIZABLE CCFL INVERTER MODULES

# PRELIMINARY DATA SHEET

#### TECHNICAL / ANALYSIS INFORMATION (continued

#### **NON-FLOATING INVERTER MEASUREMENTS**

A series of measurements were made to determine the performance of the previously used inverter with non-floating output. The exact same components were used to make the comparison.

The light out versus time test was first run to determine at which point the light output reaches a steady state. Figure 18 shows the results of this test in graphical form.

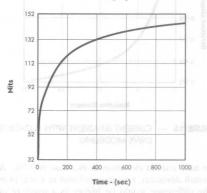


FIGURE 18 — LIGHT OUT VERSUS TIME AT INITIAL TURN ON FOR NON-FLOATING INVERTER

The light out efficiency versus time curve then has been calculated by using the light out and the power input data (Figure 20). The results of this effort are shown in Figure 19. As expected, light out efficiency improves as the lamp warms up reaching a maximum value of 38.86 Nits/Watt.

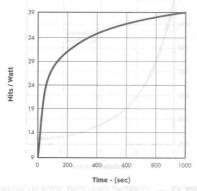


FIGURE 19 — LIGHT OUT EFFICIENCY VERSUS TIME AT INITIAL TURN ON FOR NON-FLOATING INVERTER

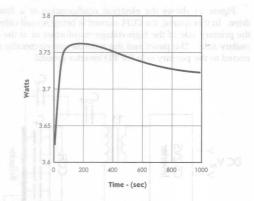


FIGURE 20 — CURRENT GRADIENT WITH FLOATING DRIVE MODELING

# FINAL ANALYSIS, FLOATING VERSUS NON-FLOATING LAMP DRIVE

Table 1 summarizes the performance differences between the floating and non-floating drive configurations evaluated in the testing discussed above. As has been seen, the performance gains strongly depend on the physical configuration of the lamp and the reflector assembly. One of the panels that was tested exhibited higher leakage, along with a significant improvement in the dimming range and the thermometer visual effect. The improvement in efficiency between floating versus non-floating in this case was 20%.

Of course, as is usually the case, improvements in performance often come with an increase in circuit complexity. While inverters employing floating output design tend to be somewhat more complex, because of the advantage realized through their use, they often are the most optimum or only viable way to drive the latest generation LCD panels.

The Current Synchronous Zero Voltage topology employed in the inverters manufactured by Linfinity Microelectronics is used in floating designs that exhibit "True Current Sense", i.e. a reflection of the actual lamp current is being sensed to provide superior lamp current regulation. This can be contrasted with the average primary current sense of Buck-Royer oscillator- based inverters. It is noteworthy that the efficiency gains of the single-power stage CS-ZVS topology compared to the double power stage Buck-ROYER combinations is more that 20%.

# FLOATING OUTPUT DRIVE, CUSTOMIZABLE CCFL INVERTER MODULES

# PRELIMINARY DATA SHEET

# TECHNICAL / ANALYSIS INFORMATION (continued)

#### TABLE 1

Parameter	Floa	ating	Non-F	loating	THE RESERVE AND DESCRIPTION OF THE PERSON NAMED IN COLUMN TWO PERSONS AND PERS	ment over loating
Input Power	3.175	Watts	3.726	Watts	-0	.3%
Light Output	154.3 Nits		144.8 Nits		6.56%	
Light Out Efficiency	41.5 N	lits/Watt	38.86 1	Nits/Watt	6.	8%
Percent Max-Min Current Difference Because of Parasitics (note 1)	0.7% at Full Bright	6.1% at 1/3 Dimmed	2.4% at Full Bright	20% at 1/3 Dimmed	242% at Full Bright	227% at 1/3 Dimmed
Dimming Range (note 2)		% of full ess Current		% of full ess Current	From	

Note 1. This refers to the max and min currents in resistive elements of the 20 element analysis. The parasitics used did not pertain exactly to the 11.3" LCD panel used to make the measurements. The results are provided for comparison purposes. It is expected that the parasitics of the panel used to make the light measurements are lower than those depicted.

Note 2. Dimming range here is defined as the point where a visible "thermometer" effect just takes place.

#### SUMMARY

Several new ways for testing CCFL's and inverters have been presented. The emphasis throughout these tests has been on how to make fair comparisons. To that end, a method has been presented that makes certain that the light output has reached steady state with all inverters tested, thus guaranteeing fair com-

The lamp/reflector parasitics were modeled and the lamp current profile was calculated based on these models. This gave insights on the effect of the parasitics either when the lamp is at full brightness or dimmed. Both the non-floating and floating inverter designs were considered and analyzed.

The use of a floating lamp architecture resulted in approximately a 6.8% improvement in light output efficiency when it was compared to a non-floating design. The dimming range with the floating drive was also better by more than 15%.

The comparison between the floating versus the non-floating drive designs were presented in tabular form for easy evalu-



# FLOATING OUTPUT DRIVE, CUSTOMIZABLE CCFL INVERTER MODULES

## PRELIMINARY DATA SHEET

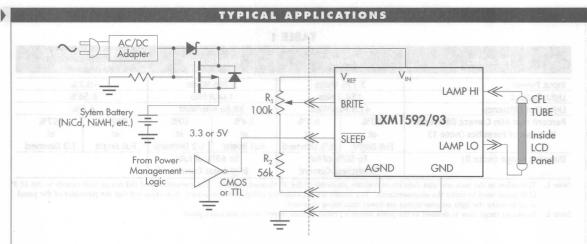


FIGURE 21 — NOTEBOOK SYSTEM APPLICATION

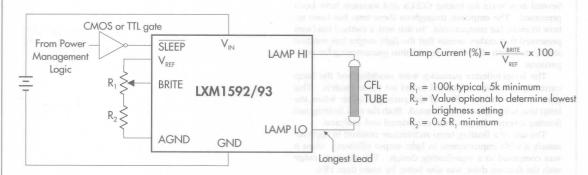
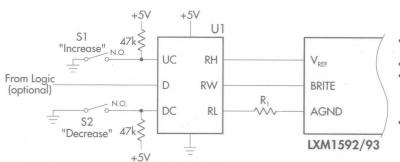


FIGURE 22 — POTENTIOMETER BRIGHTNESS CONTROL & SLEEP MODE



• S1 & S2 are momentary push buttons, normally open contacts.

• U1 = 100k digital pot.

R<sub>1</sub> value optional for choosing dimming

for  $R_1 = 100k$ , Range = 100% to 50% for  $R_1 = 50k$ , Range = 100% to 33%

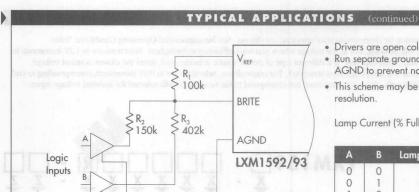
• R, minimum value is 0.5 Rpor.

FIGURE 23 — NONVOLATILE DIGITAL BRIGHTNESS CONTROL



# FLOATING OUTPUT DRIVE, CUSTOMIZABLE CCFL INVERTER MODULES

# PRELIMINARY DATA SHEET

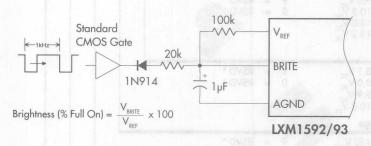


- - · Drivers are open collector. Run separate ground from driver chip to LXM1592/93 AGND to prevent noise pickup.
  - This scheme may be expanded to 3 or 4 bits for more resolution.

Lamp Current (% Full On) = 
$$\frac{V_{BRITE}}{V_{REF}} \times 100$$

Α	В	Lamp Current
0	0	52%
0	1	60%
1	0	80%
1.	1	100%

FIGURE 24 — LOW COST DIGITAL BRIGHTNESS CONTROL



Lamp Current
100%
70%
33%

100% DC is a logic HI at CMOS gate input.

FIGURE 25 — PWM BRIGHTNESS CONTROL

# FLOATING OUTPUT DRIVE, CUSTOMIZABLE CCFL INVERTER MODULES

#### PRELIMINARY DATA SHEET

## COMPLETING THE MODULE PART NUMBER

- 1. Choose either the half or full-bridge version by determining your operating conditions. See Recommended Operating Conditions Table.
- 2. Choose the nominal input voltage you will be using, that is, the voltage where you want efficiency to be highest. Selections are in 1.2V increments to match the 1.2V/cell potential of NiCd and NiMH batteries. If a different type of power source is being used, select the closest nominal voltage.
- 3. Choose the minimum input voltage where full lamp brightness is needed. For convenience, selections are in 0.9V increments, corresponding to end of discharge potential for NiCd and NiMH cells. Your selection need not correspond to the number of cells selected for nominal voltage input.
- 4. Specify lamp running voltage.
- 5. Specify maximum lamp start voltage.
- **6.** Specify lamp running current.



# Module Type

- 2 = Half-Bridge Drive (7.0V to 30V Battery Voltage)
- 3 = Full-Bridge Drive (4.5V to 6.5V Battery Voltage)

# Nominal Input Voltage (4 thru 11 NiMH cells)

1	=	4.8 V	5	=	9.6 V <sub>DC</sub>	9	=	RSVD *
2	=	4.8 V <sub>DC</sub> 6.0 V <sub>DC</sub> 7.2 V <sub>DC</sub>	6	=	10.8 V	0	=	RSVD *
3	=	7.2 V	7	=	12.0 V <sub>DC</sub>			
4	=	8.4 V <sub>DC</sub>	8	=	13.2 V <sub>DC</sub>			

## Minimum Input Voltage

1	=	4.5 V <sub>DC</sub>	5	=	8.1 V <sub>DC</sub>	9	=	RSVD
2	=	5.4 Vpc	6	=	9.0 V	0	=	<b>RSVD</b>
3	=	5.4 V <sub>DC</sub> 6.3 V <sub>DC</sub>	7	=	9.9 VDC			
4	=	7.2 V <sub>DC</sub>	8	=	10.8 V <sub>DC</sub>			

#### Nominal Lamp Operating Voltage

1	=	250 V <sub>PMS</sub>	5	=	450 V <sub>RMS</sub>	9	=	RSVD *
2	=	300 V <sub>PMS</sub>	6	=	500 V	0	=	RSVD *
3	=		7	=	550 V <sub>PMS</sub>			
4	=	400 V <sub>RMS</sub>	8	=	600 V <sub>RMS</sub>			

#### Maximum Lamp Start Voltage

1	=	600 V <sub>RMS</sub>	4	2	900 V	7	=	1200 V <sub>RMS</sub>
2	=	700 V <sub>RMS</sub>	5	=	900 V <sub>RMS</sub> 1000 V <sub>RMS</sub>	8	=	1300 V <sub>RMS</sub>
3	=	800 V <sub>RMS</sub>	6	=	1100 V <sub>RMS</sub>	9	=	1400 V <sub>RMS</sub>

## Nominal Lamp Operating Current at Full Brightness

THE RESIDENCE	STREET, SQUARE,	THE RESERVE OF THE PARTY OF THE	-	-	THE RESERVE THE PERSON NAMED IN COLUMN TWO	CONTRACTOR OF THE PARTY OF THE		
1	= /	2 mA <sub>RMS</sub>	5	=	6 mA <sub>RMS</sub>	9	=	RSVD *
2	=0	3 mA	6	=	7 mA <sub>sus</sub>	0	=	RSVD *
3	=	4 mA	7	=	$10 \text{ mA}_{\text{pus}}$			
4	=	5 mA <sub>RMS</sub>	8	=	12 mA <sub>RMS</sub>			

#### Reserved

**Mechanical Configuration** 

Factory Assigned

RSVD = Reserved for Special Requirements

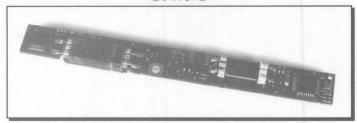


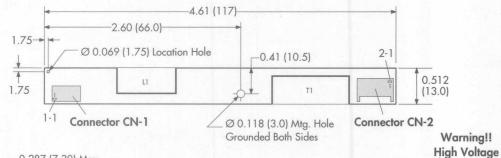
# FLOATING OUTPUT DRIVE, CUSTOMIZABLE CCFL INVERTER MODULES

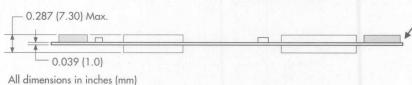
# PRELIMINARY DATA SHEET

# PHYSICAL DIMENSIONS

LXM1592







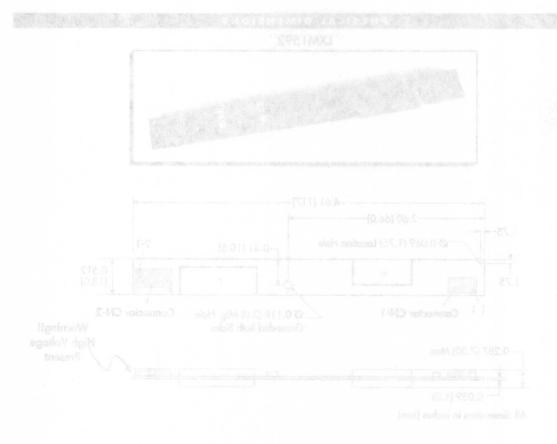
CN-1 = JST P/N: 05FMS-1.0SP

CN-2 = JST P/N: SM02-(8.0)B-BHS-1-TB

Present

# Notes

PRESIDENCE BATE SHEET



CN-1 = JST P/N: 05PMS-1.05P

CN-2 = 1ST P/N: SM02-(8.0)8-8HS-1-T8





WIDE INPUT CCFL INVERTER MODULES

THE INFINITE POWER OF INNOVATION PRELIMINARY DATA SHEET

## DESCRIPTION

LXM1596-01 CCFL (cold cathode florescent lamp) Inverter Modules are specifically designed for driving LCD back light lamps in applications where dimmability, ultrahigh efficiency, high light output, low noise emissions, reliable fail safe design, and small form factors are critical parameters. Both monochrome and color displays are supported.

The modules convert unregulated DC voltage from the system battery or AC adapter directly to high-frequency, highvoltage sine waves required to ignite and operate CCFL lamps. The module design is based on a proprietary Linfinity IC that provides important new performance ad-

Remarkable improvements in efficiency and RF emissions result from its single stage resonant inverter featuring a patent pending Current Synchronous, Zero Voltage Switching (CS-ZVS) topology. CS-ZVS produces nearly pure sine wave currents in the lamp enabling maximum light delivery while reducing both conducted and radi-

ated noise. This topology simultaneously performs three tasks consisting of line voltage regulation, lamp current regulation, and lamp dimming in a single power stage made up of one pair of low loss FET's. The FET's drive an LC resonant circuit that feeds the primary of a high voltage transformer with a sinusoidal voltage.

Required L and C values in the resonant circuit are such that very low loss components can be used to obtain higher electrical efficiency than is possible with previous topologies.

The half bridge LXM1596-01 is optimized to efficiently operate with up to 4 watt lamps over the full 7V to 30V input volt-

The modules are equipped with a dimming input that permits full range brightness control from an external potentiometer, and a sleep input that reduces module power to a few microwatts in shut down mode.

All modules feature output open and short circuit protection.

## KEY FEATURES

- 15 to 30% MORE LIGHT OUTPUT
- CLOSED LOOP, FULLY REGULATING DESIGN
- 7V TO 30V INPUT VOLTAGE RANGE
- VERSATILE BRIGHTNESS CONTROL INPUT
- 3 MICROAMP SLEEP CURRENT
- OUTPUT SHORT CIRCUIT PROTECTION AND AUTOMATIC OVER VOLTAGE LIMITING
- 8mm MAX HEIGHT, NARROW FOOTPRINTS
- SINGLE SIDED PCB IS SELF INSULATING

#### APPLICATIONS

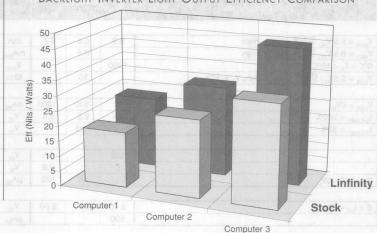
- NOTEBOOK AND SUB-NOTEBOOK COMPUTERS
- PERSONAL DIGITAL ASSISTANTS
- PORTABLE INSTRUMENTATION
- AUTOMOTIVE DISPLAYS
- DESKTOP DISPLAYS
- AIRLINE ENTERTAINMENT CENTERS

#### BENEFITS

- ULTRA-HIGH EFFICIENCY, LINE VOLTAGE REGULATION AND SLEEP MODE EXTEND COMPUTER BATTERY LIFE
- COOL OPERATION PERMITS CLOSE PROXIMITY TO LCD PANEL WITHOUT DISPLAY DISTORTION
- SMOOTH, FULL-RANGE BRIGHTNESS CONTROL GIVES YOUR PRODUCT A HIGH QUALITY IMAGE
- LOW EMI / RFI DESIGN MINIMIZES SHIELDING REQUIREMENTS
- NARROW, LOW PROFILE STANDARD MODULES FIT INTO MOST LCD **ENCLOSURES**
- SINGLE SIDED PCB SAVES EXPENSIVE HIGH VOLTAGE INSULATING TAPES

## PRODUCT HIGHLIGHT





## MODULE ORDER INFORMATION

7V - 30V INPUT

LXM1596-01

FOR FURTHER INFORMATION CALL (714) 898-8121

# WIDE INPUT CCFL INVERTER MODULES

# TRIBE ATAG YRAM PRELIMINARY DATA SHEET

#### 

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

# RECOMMENDED OPERATING CONDITIONS (R.C.)

This module has been designed to operate over a wide range of input and output conditions. However, best efficiency and performance will be obtained if the module is operated under the condition listed in the 'R.C.' column. Min. and Max. columns indicate values beyond which the inverter, although operational, will not function optimally.

Parameter	Symbol	Recomme	Units		
Falallietel	Symoon	Min.	R.C.	Max.	Oilles
Input Supply Voltage	V <sub>IN</sub>	7	12	30	V
Output Power	Po	a gitteri ag	2.5	4.0	W
Brightness Control Input Voltage Range	V <sub>BRITE</sub>	0.8	tall around a status	2.5	٧
Lamp Operating Voltage	VLAMP	240	500	650	V <sub>RMS</sub>
Lamp Current - Full Brightness	IOLAMP	abom a	5	s same 7	mA <sub>RMS</sub>
Operating Ambient Temperature Range	or mides T <sub>A</sub> stubio	0	sciences bight delive	60	°C

## **ELECTRICAL CHARACTERISTICS**

Unless otherwise specified, these specifications apply over the recommended operating conditions and 25°C ambient temperature for the LXM1596.

Baramatar	Cumbal	Test Conditions	THE TOTAL	Units		
Parameter	Symbol	Test Conditions	Min.	Тур.	Max.	Omit
Output Pin Characteristics						
Full Bright Lamp Current	I <sub>L (MAX)</sub>	$V_{BRITE} = 2.5 V_{DC}$ , SLEEP = Logic High	6.2	6.6	7.0	mA
Minimum Lamp Current	I <sub>L (MIN)</sub>	V <sub>BRITE</sub> = 0.8 V <sub>DC</sub> , SLEEP = Logic High		2.6	- CP	mA <sub>RM</sub>
Lamp Start Voltage	V <sub>LS</sub>	0°C < T <sub>A</sub> < 60°C	1300	-	0.5	V <sub>RMS</sub>
Operating Frequency	fo	V <sub>BRITE</sub> = 2.5V <sub>DC</sub> , SLEEP = Logic High, V <sub>IN</sub> = 12V		50	-86	KHz
Brightness Control			E CONTRACTOR OF THE PARTY OF TH	4	ne	i i
Input Current	I <sub>BRITE</sub>	$V_{BRITE} = OV_{DC}$		-200	-1000	nApo
Input Voltage for Max. Lamp Current	V <sub>c</sub>	I <sub>O (LAMP)</sub> = 100%	2.4	2.5	2.6	V <sub>DC</sub>
Input Voltage for 50% Lamp Current	V <sub>c</sub>	I <sub>O (LAMP)</sub> = 50%		1.25	02	V <sub>DC</sub>
SLEEP Input					15	11/
Input Logic 1	V <sub>IH</sub>		2.2	no!	5.5	V <sub>DC</sub>
Input Logc 0	V <sub>IL</sub>		0		0.8	V <sub>DC</sub>
Input Current	I <sub>IN</sub>	$V_{\overline{\text{SLEEP}}} = 0 - 5V_{DC}$	THE STATE	50	100	μA <sub>DC</sub>
Voltage Reference						
Output Voltage	V <sub>REF</sub>	0 < I <sub>REF</sub> < 500µA	2.40	2.50	2.60	V <sub>DC</sub>
Output Current	IREF	Compular 2	500			μA <sub>DC</sub>
Power Characteristics		Cemputár S				
Sleep Current	I <sub>IN (MIN)</sub>	$V_{IN} = 5V_{DC}$ , $\overline{SLEEP} = Logic 0$		3	10	μA <sub>DC</sub>
Electrical Efficiency (calculated values)	η	LXM1596, V <sub>IN</sub> = 12V <sub>DC</sub> , I <sub>O (LAMP)</sub> = 5mA <sub>RMS</sub>		90		%

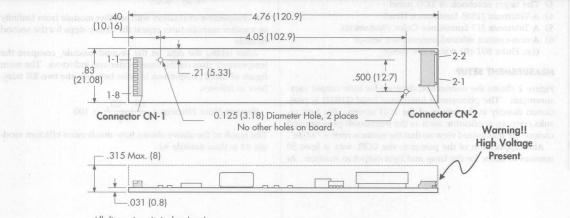


# WIDE INPUT CCFL INVERTER MODULES

# PRELIMINARY DATA SHEET

<b>以</b>		FUNCTIONAL PIN DESCRIPTION
Conn.	Pin	Description
CN1	101 x 100	Company Control (S) =
CN1-1 CN1-2	V <sub>IN</sub>	Input voltage. (+7 to +30V <sub>DC</sub> )
CN1-3	N.C.	No Connect. See See See See See See See See See Se
CN1-4 CN1-5	GND	Power supply return.
CN1-6	SLEEP	Logical high on this pin enables inverter operation. Logical low removes power from the module and the lamp. A floating input is sensed as a logical low and will disable inverter operation. If not used, connect $\overline{\text{SLEEP}}$ through a 33k $\Omega$ resistor to $V_{\text{IN}}$ or directly to any voltage between 2.5 and 5.5V. May be used to modulate lamp intensity by varying duty cycle.
CN1-7	BRITE	Brightness control input. Apply 0.8 to 2.5 volts DC to control lamp brightness. Lamp current varies linearly with input voltage. 2.5V gives maximum brightness.
CN1-8	V <sub>REF</sub>	Reference Voltage Output. 2.5V @ 500µA max. For use with external dimming circuit.
CN2	erina pur es	Inveners is by directly measuring tight output versus power. (1 count = 1 kind, as well as imput volta
CN2-1	LAMP LO	High voltage connection to low side of lamp. Connect to lamp terminal with longer lead length. Do not connect to ground.
CN2-2	LAMP HI	High voltage connection to high side of lamp. Connect to lamp terminal with shortest lead length. Do no connect to ground.

# MECHANICAL OUTLINE



All dimensions in inches (mm)

# **Connectors:**

CN-1 = MOLEX 53261-0890

**CN-2** = JST SM02(8.0) B-BHS-TB

# **Recommended Mate:**

Pins: 50079-8100\*, Housing: 51021-0800 \* Loose (-8000, Chain) Recommended #26 AWG wiring

Pins: 5BH-001T-P0.5, Housing: BHR-03VS-1

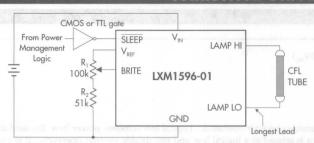
Note: All samples are equipped with connector mates and cable.



# WIDE INPUT CCFL INVERTER MODULES

# PRELIMINARY DATA SHEET

#### CONNECTION DIAGRAM



 $Lamp Current (\%) = \frac{V_{BRITE}}{V_{DEE}} \times 100$ 

 $R_1 = 100k$  typical, 5k minimum

R<sub>2</sub> = Value optional to determine lowest brightness setting

 $R_2 = 0.5 R$ , minimum

FIGURE 1 — RECOMMENDED CONNECTION DIAGRAM

#### FFEICIENCY MEASUREMENT SETUP

#### INTRODUCTION

The best method for evaluating high voltage, high frequency inverters is by directly measuring light output versus power input. This method is highly recommended when evaluating inverter modules.

The following sections outline the recommended method for testing these modules.

#### **EQUIPMENT REQUIRED**

- 1) Two DVM's with 0.1% or better accuracy.
- 2) A lab power supply. (0 20V, 0 2A)
- 3) The target notebook or LCD panel.
- 4) A Tektronix J1803 Luminance Head.
- 5) A Tektronix J17 Luminance Color Photometer.
- 6) A non-contact infrared temperature sensor (i.e. Fluke 80T-IR) with a mV meter.

#### MEASUREMENT SETUP

Figure 2 shows the connection diagram for light output measurements. The photometer luminance head (J1803) is positioned directly in the center of the LCD screen. For best results open an application such as the Paintbrush program and choose the maximized view so that the entire screen is "white".

After application of the power to the CCFL wait at least 30 minutes to allow for the lamp and light output to stabilize. At

the end of the 30 minute period read the light output in  $cd/m^2$  (1  $cd/m^2$  = 1 Nit), as well as input voltage and current. Typical applications require about 70 to 100 Nits out of the screen. With the temperature probe record the temperature rises of critical components such as the high voltage transformer and the inductor.

The light output efficiency of the module can be calculated by the following equation:

Eff = 
$$\frac{\text{Light Output (in Nits)}}{V_{\text{IN (DC)}} * I_{\text{IN (DC)}}} = \frac{\text{Nits}}{\text{Watt}}$$

For competitive evaluation with another module from Linfinity or another manufacturer repeat the above steps for the second module.

After taking the data on the second module, compare the temperature rises on the transformer and inductors. The main figure of merit comparison is done between the two Eff numbers as follows:

Percent More Efficient = 
$$\frac{\text{Eff}_1 - \text{Eff}_2}{\text{Eff}_2} * 100$$

The result of the above shows how much more efficient module #1 is than module #2.

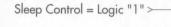
# WIDE INPUT CCFL INVERTER MODULES

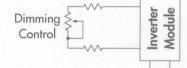
# PRELIMINARY DATA SHEET

# DC DC DC Power Supply Amp Meter Volt Meter

0-







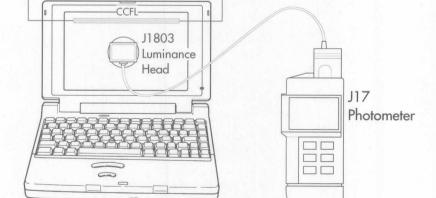
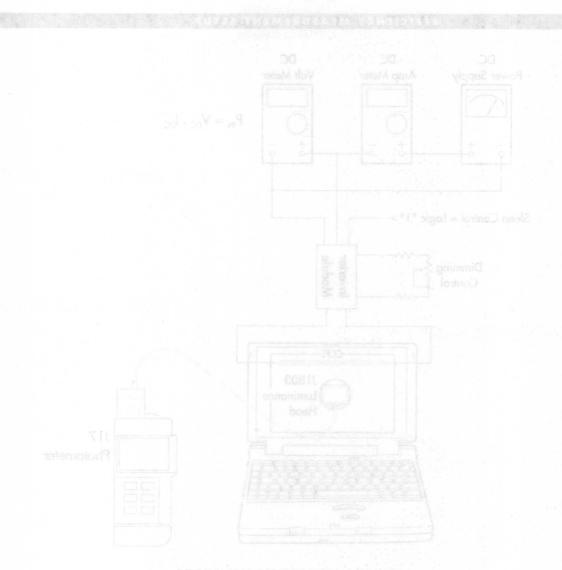


FIGURE 2 — LIGHT OUTPUT MEASUREMENT SETUP

# Notes

PRILIBERARY DATA SHEET



MANAGES -- TREAL ORIGINAL WEVERSONE WEST



5 V CCFL INVERTER MODULES

THE INFINITE POWER OF INNOVATION PRELIMINARY DATA SHEET

## DESCRIPTION

LXM1597-01 CCFL (cold cathode florescent lamp) Inverter Modules are specifically designed for driving LCD back light lamps in applications where dimmability, ultra-high efficiency, high light output, low noise emissions, reliable fail safe design, and small form factors are critical parameters. Both monochrome and color displays are supported.

The modules convert unregulated DC voltage from the system battery or AC adapter directly to high-frequency, highvoltage sine waves required to ignite and operate CCFL lamps. The module design is based on a proprietary Linfinity IC that provides important new performance advances.

Remarkable improvements in efficiency and RF emissions result from its single stage resonant inverter featuring a patent pending Current Synchronous, Zero Voltage Switching (CS-ZVS) topology. CS-ZVS produces nearly pure sine wave currents in the lamp enabling maximum light delivery while reducing both conducted and radiated noise. This topology simultaneously performs three tasks consisting of line voltage regulation, lamp current regulation, and lamp dimming in a single power stage made up of two pairs of low loss FET's. The FET's drive an LC resonant circuit that feeds the primary of a high voltage transformer with a sinusoidal voltage.

Required L and C values in the resonant circuit are such that very low loss components can be used to obtain higher electrical efficiency than is possible with previous topologies.

The full bridge LXM1597-01 is optimized to efficiently operate with up to 4 watt lamps at input voltages of 5 volts. This module will operate over the full 4.5V to 7V input voltage range.

The modules are equipped with a dimming input that permits full range brightness control from an external potentiometer, and a sleep input that reduces module power to a few microwatts in shut down mode.

All modules feature output open and short circuit protection.

## **KEY FEATURES**

- 15 to 30% MORE LIGHT OUTPUT
- CLOSED LOOP, FULLY REGULATING DESIGN
- 4.5V TO 7V INPUT VOLTAGE RANGE
- VERSATILE BRIGHTNESS CONTROL INPUT
- 3 MICROAMP SLEEP CURRENT
- OUTPUT SHORT CIRCUIT PROTECTION AND AUTOMATIC OVER VOLTAGE LIMITING
- 8mm MAX HEIGHT, NARROW FOOTPRINTS
- SINGLE SIDED PCB IS SELF INSULATING

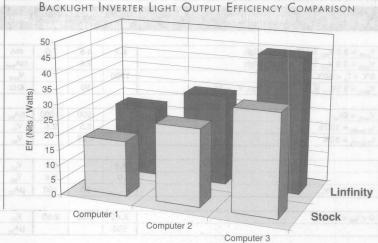
## APPLICATIONS

- NOTEBOOK AND SUB-NOTEBOOK COMPUTERS
- PERSONAL DIGITAL ASSISTANTS
- PORTABLE INSTRUMENTATION
- AUTOMOTIVE DISPLAYS
- DESKTOP DISPLAYS
- AIRLINE ENTERTAINMENT CENTERS

#### BENEFITS

- ULTRA-HIGH EFFICIENCY, LINE VOLTAGE REGULATION AND SLEEP MODE EXTEND COMPUTER BATTERY LIFE
- COOL OPERATION PERMITS CLOSE PROXIMITY TO LCD PANEL WITHOUT DISPLAY DISTORTION
- SMOOTH, FULL-RANGE BRIGHTNESS CONTROL GIVES YOUR PRODUCT A HIGH QUALITY IMAGE
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- NARROW, LOW PROFILE STANDARD MODULES FIT INTO MOST LCD **ENCLOSURES**
- SINGLE SIDED PCB SAVES EXPENSIVE HIGH VOLTAGE INSULATING TAPES

# PRODUCT HIGHLIGHT



MODULE ORDER INFORMATION

5 V INPUT

LXM1597-01

FOR FURTHER INFORMATION CALL (714) 898-8121

# 5 V CCFL INVERTER MODULES

# THE RELIGIOUS ATA O YEAR PRELIMINARY DATA SHEET

ABSOLUTE MAXIMUM RA	TINGS (Note 1)
Input Supply Voltage (V <sub>IN</sub> ) Output Voltage, no load Output Current Output Power	
Input Signal Voltage, (SLEEP and BRITE Inputs)	
Ambient Operating Temperature, zero airflow Storage Temperature Range	0°C to 60°C
Note 1. Exceeding these ratings could cause damage to the device. All voltages are wi	

# RECOMMENDED OPERATING CONDITIONS (R.C.)

This module has been designed to operate over a wide range of input and output conditions. However, best efficiency and performance will be obtained if the module is operated under the condition listed in the 'R.C.' column. Min. and Max. columns indicate values beyond which the inverter, although operational, will not function optimally.

Parameter	Symbol	Recommended Operating Conditions			
Farameter	Symoon	Min. R.C.		Max.	Units
Input Supply Voltage	V <sub>IN</sub>	4.5	5	7	V
Output Power	Po	And the state of t	2.5	4.0	W
Brightness Control Input Voltage Range	V <sub>BRITE</sub>	0.8	di straterian-war	2.5	V
Lamp Operating Voltage	V <sub>LAMP</sub>	240	500	650	V <sub>RMS</sub>
Lamp Current - Full Brightness	streets sugar sem locamp	milla reid	5	boller 7 rod st	mA <sub>RMS</sub>
Operating Ambient Temperature Range	Taitesia	Rusti 0 aus	phog victoria	60	°C

<b>医多种性的 医多种性性</b>	EL	ECTRICAL CHARACTERISTICS				
Unless otherwise specified, these specified	ications a	pply over the recommended operating conditions and 25°C at	mbient ter	mperatur	e for the	LXM159
Parameter	Symbol	Test Conditions	LXM1597			Units
raidiletei	Symoon	rest conditions	Min.	Тур.	Max.	Units
Output Pin Characteristics						
Full Bright Lamp Current	I <sub>L (MAX)</sub>	V <sub>BRITE</sub> = 2.5 V <sub>DC</sub> , SLEEP = Logic High	6.2	6.6	7.0	mA
Minimum Lamp Current	I <sub>L (MIN)</sub>	V <sub>BRITE</sub> = 0.8 V <sub>DC</sub> , SLEEP = Logic High		2.6	100	mA <sub>RMS</sub>
Lamp Start Voltage	V <sub>LS</sub>	0°C < T <sub>A</sub> < 60°C			1.0%	V <sub>RMS</sub>
Operating Frequency	fo	$V_{BRITE} = 2.5V_{DC}$ , SLEEP = Logic High, $V_{IN} = 5V$		50	35-1	KHz
Brightness Control				-	Loc	法
Input Current	IBRITE	$V_{BRITE} = OV_{DC}$	1	-200	-1000	nApc
Input Voltage for Max. Lamp Current	V <sub>c</sub>	I <sub>O (LAMP)</sub> = 100%	2.4	2.5	2.6	V <sub>DC</sub>
Input Voltage for 50% Lamp Current	V <sub>c</sub>	I <sub>O (LAMP)</sub> = 50%		1.25	1-U5	V <sub>DC</sub>
SLEEP Input				13-1	151	(0)
Input Logic 1	V <sub>IH</sub>		2.2	100	5.5	V <sub>DC</sub>
Input Logc 0	V <sub>IL</sub>		0	BUIL	0.8	V <sub>DC</sub>
Input Current	I <sub>IN</sub>	$V_{\overline{SLEEP}} = 0 - 5V_{DC}$	100 11	50	100	μA <sub>DC</sub>
Voltage Reference			8/5/11/1			
Output Voltage	V <sub>REF</sub>	0 < I <sub>REF</sub> < 500μA	2.40	2.50	2.60	V <sub>DC</sub>
Output Current	I <sub>REF</sub>	S settlemon	500	1		μA <sub>DC</sub>
Power Characteristics		Compiler 3				
Sleep Current	I <sub>IN (MIN)</sub>	$V_{IN} = 5V_{DC}$ , $\overline{SLEEP} = Logic 0$		3	10	μA <sub>DC</sub>
Electrical Efficiency (calculated values)	η	LXM1597, $V_{IN} = 5V_{DC}$ , $I_{O(LAMP)} = 5mA_{RMS}$		90		%

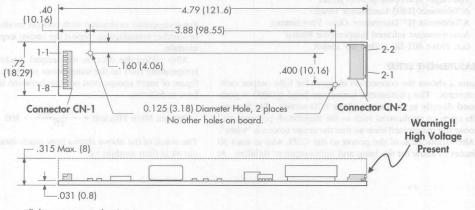


# 5 V CCFL INVERTER MODULES

# PRELIMINARY DATA SHEET

Days.	FUNCTIONAL PIN DESCRIPTION					
Conn.	Pin	Description				
CN1	nor seme	s (20) speciment against				
CN1-1 CN1-2	V <sub>IN</sub>	Input voltage. (+4.5 to +7V <sub>DC</sub> )				
CN1-3 CN1-4	GND	Power supply return.				
CN1-5	SLEEP	Logical high on this pin enables inverter operation. Logical low removes power from the module and the lamp. A floating input is sensed as a logical low and will disable inverter operation. If not used, connect $\overline{\text{SLEEP}}$ through a 33k $\Omega$ resistor to $V_{\text{IN}}$ or directly to any voltage between 2.5 and 5.5V. May be used to modulate lamp intensity by varying duty cycle.				
CN1-6	BRITE	Brightness control input. Apply 0.8 to 2.5 volts DC to control lamp brightness. Lamp current varies linearly with input voltage. 2.5V gives maximum brightness.				
CN1-7	AGND	Brightness control signal return. For best results do not run 5V power supply current return through this pin.				
CN1-8	V <sub>REF</sub>	Reference Voltage Output. 2.5V @ 500µA max. For use with external dimming circuit.				
CN2	nemua best ne	inverters a by directly incustions believeled versus power. Tradent = 1 hist, as well as input volta				
CN2-1	LAMP LO	High voltage connection to low side of lamp. Connect to lamp terminal with longer lead length. Do not connect to ground.				
CN2-2	LAMP HI	High voltage connection to high side of lamp. Connect to lamp terminal with shortest lead length. Do not connect to ground.				

# MECHANICAL OUTLINE



All dimensions in inches (mm)

# Connectors:

CN-1 = MOLEX 53261-0890

CN-2 = JST SM02(8.0) B-BHS-TB

# Recommended Mate:

Pins: 50079-8100\*, Housing: 51021-0800
\* Loose (-8000, Chain) Recommended #26 AWG wiring

Pins: 5BH-001T-P0.5, Housing: BHR-03VS-1

Note: All samples are equipped with connector mates and cable.



# 5 V CCFL INVERTER MODULES

## PRELIMINARY DATA SHEET

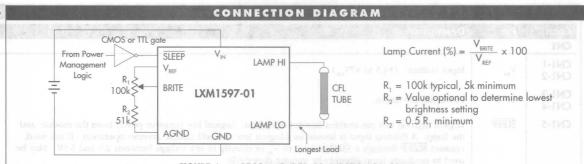


FIGURE 1 — RECOMMENDED CONNECTION DIAGRAM

#### EFFICIENCY MEASUREMENT

#### INTRODUCTION

The best method for evaluating high voltage, high frequency inverters is by directly measuring light output versus power input. This method is highly recommended when evaluating inverter modules.

The following sections outline the recommended method for testing these modules.

#### **EQUIPMENT REQUIRED**

- 1) Two DVM's with 0.1% or better accuracy
- 2) A lab power supply. (0 20V, 0 2A)
- 3) The target notebook or LCD panel.
- 4) A Tektronix J1803 Luminance Head.
- 5) A Tektronix J17 Luminance Color Photometer.
- 6) A non-contact infrared temperature sensor (i.e. Fluke 80T-IR) with a mV meter.

#### **MEASUREMENT SETUP**

Figure 2 shows the connection diagram for light output measurements. The photometer luminance head (J1803) is positioned directly in the center of the LCD screen. For best results open an application such as the Paintbrush program and Percent More Efficient =  $\frac{\text{Eff}_1 - \text{Eff}_2}{\text{Eff}_1}$  • 100 choose the maximized view so that the entire screen is "white".

After application of the power to the CCFL wait at least 30 minutes to allow for the lamp and light output to stabilize. At the end of the 30 minute period read the light output in cd/m<sup>2</sup> (1 cd/m<sup>2</sup> = 1 Nit), as well as input voltage and current. Typical applications require about 70 to 100 Nits out of the screen. With the temperature probe record the temperature rises of critical components such as the high voltage transformer and the inductor.

The light output efficiency of the module can be calculated by the following equation:

$$Eff = \frac{Light Output (in Nits)}{V_{IN (DC)} * I_{IN (DC)}} = \frac{Nits}{Watt}$$

For competitive evaluation with another module from Linfinity or another manufacturer repeat the above steps for the second

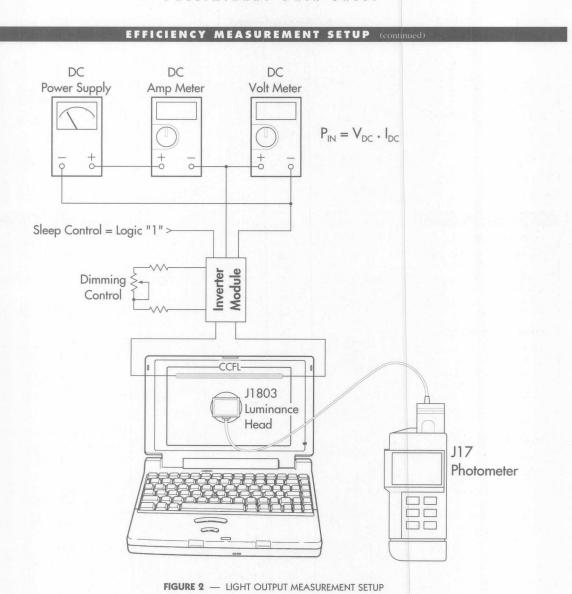
After taking the data on the second module, compare the temperature rises on the transformer and inductors. The main figure of merit comparison is done between the two Eff numbers as follows:

Percent More Efficient = 
$$\frac{\text{Eff}_1 - \text{Eff}_2}{\text{Eff}_2}$$
 \* 100

The result of the above shows how much more efficient module #1 is than module #2.

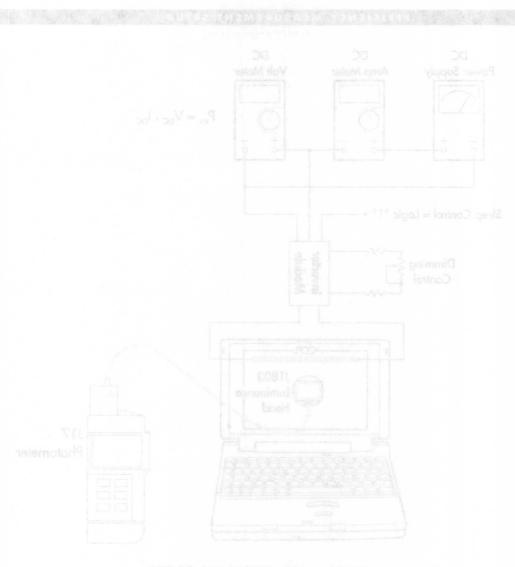
# 5 V CCFL INVERTER MODULES

# PRELIMINARY DATA SHEET



# Notes

TITUE STAR VULBER SHEET



RECORD & - LIGHT OUTEN MEASUREMENT SETS





#### LXM1598-01

#### 12V CCFL INVERTER MODULES

THE INFINITE POWER OF INNOVATION PRELIMINARY DATA SHEET

#### DESCRIPTION

LXM1598-01 CCFL (cold cathode florescent lamp) Inverter Modules are specifically designed for driving LCD back light lamps in applications where dimmability, ultrahigh efficiency, high light output, low noise emissions, reliable fail safe design, and small form factors are critical parameters. Both monochrome and color displays are supported.

The modules convert unregulated DC voltage from the system battery or AC adapter directly to high-frequency, highvoltage sine waves required to ignite and operate CCFL lamps. The module design is based on a proprietary Linfinity IC that provides important new performance ad-

Remarkable improvements in efficiency and RF emissions result from its single stage resonant inverter featuring a patent pending Current Synchronous, Zero Voltage Switching (CS-ZVS) topology. CS-ZVS produces nearly pure sine wave currents in the lamp enabling maximum light delivery while reducing both conducted and radiated noise. This topology simultaneously performs three tasks consisting of line voltage regulation, lamp current regulation, and lamp dimming in a single power stage made up of one pair of low loss FET's. The FET's drive an LC resonant circuit that feeds the primary of a high voltage transformer with a sinusoidal voltage.

Required L and C values in the resonant circuit are such that very low loss components can be used to obtain higher electrical efficiency than is possible with previous topologies.

The half bridge LXM1598-01 is optimized to efficiently operate with up to 4 watt lamps over the full 10V to 14V input voltage range.

The modules are equipped with a dimming input that permits full range brightness control from an external potentiometer, and a sleep input that reduces module power to a few microwatts in shut down mode.

All modules feature output open and short circuit protection.

#### KEY FEATURES

- 15 to 30% MORE LIGHT OUTPUT
- CLOSED LOOP, FULLY REGULATING DESIGN
- 10V TO 14V INPUT VOLTAGE RANGE
- VERSATILE BRIGHTNESS CONTROL INPUT
- 3 MICROAMP SLEEP CURRENT
- OUTPUT SHORT CIRCUIT PROTECTION AND AUTOMATIC OVER VOLTAGE LIMITING
- 8mm MAX HEIGHT, NARROW FOOTPRINT

#### APPLICATIONS

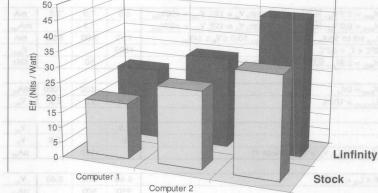
- NOTEBOOK AND SUB-NOTEBOOK COMPUTERS
- PERSONAL DIGITAL ASSISTANTS
- PORTABLE INSTRUMENTATION
- AUTOMOTIVE DISPLAYS
- DESKTOP DISPLAYS
- AIRLINE ENTERTAINMENT CENTERS

#### BENEFITS

- ULTRA-HIGH EFFICIENCY, LINE VOLTAGE REGULATION AND SLEEP MODE EXTEND COMPUTER BATTERY LIFE
- COOL OPERATION PERMITS CLOSE PROXIMITY TO LCD PANEL WITHOUT DISPLAY DISTORTION
- SMOOTH, FULL-RANGE BRIGHTNESS CONTROL GIVES YOUR PRODUCT A HIGH QUALITY IMAGE
- LOW EMI / RFI DESIGN MINIMIZES SHIELDING REQUIREMENTS
- NARROW LOW PROFILE STANDARD MODULES FIT INTO MOST LCD **ENCLOSURES**

#### PRODUCT HIGHLIGHT BACKLIGHT INVERTER LIGHT OUTPUT EFFICIENCY COMPARISON





#### MODULE ORDER INFORMATION

Computer 3

10V - 14V INPUT

LXM1598-01

FOR FURTHER INFORMATION CALL (714) 898-8121

the specified terminal.

# LXM1598-01

#### 12V CCFL INVERTER MODULES

#### PRELIMINARY DATA SHEET

ABSOLUTE MAXIMUM RAT	INGS (Note 1)
Input Supply Voltage (V <sub>IN</sub> )	-0.3V to 20V
Output Voltage, no load	
Output Current	
Output Power	4.2W
Output Power	-0.3V to 6.5V
Ambient Operating Temperature, zero airflow	0°C to 60°C
Storage Temperature Range	-40°C to 85°C
Note 1. Exceeding these ratings could cause damage to the device. All voltages are with	

#### RECOMMENDED OPERATING CONDITIONS (R.C.)

This module has been designed to operate over a wide range of input and output conditions. However, best efficiency and performance will be obtained if the module is operated under the condition listed in the 'R.C.' column. Min. and Max. columns indicate values beyond which the inverter, although operational, will not function optimally.

Parameter	Symbol	Recommen	Units		
raidilletei	Symoon	Min.	R.C.	Max.	Units
Input Supply Voltage	V <sub>IN</sub>	10	12	14	V
Output Power	Po	a green age	2.5	4.0	W
Brightness Control Input Voltage Range	V <sub>BRITE</sub>	0.0	Torre Veri	2.2	٧
Lamp Operating Voltage	V <sub>LAMP</sub>	240	500	650	V <sub>RMS</sub>
Lamp Current - Full Brightness	IOLAMP	labout ni s	5	near 7 pure sin	mA <sub>RMS</sub>
Operating Ambient Temperature Range	ranes T <sub>A</sub> shubor	UA O STEE	mum hghretisii	60	°C

#### **ELECTRICAL CHARACTERISTICS**

Unless otherwise specified, these specifications apply over the recommended operating conditions and 25°C ambient temperature for the LXM1598.

Parameter	Symbol	Test Conditions		LXM159	8	Units
raiametei	Sylliooi	rest conditions		Тур.	Max.	Oilits
Output Pin Characteristics						
Full Bright Lamp Current	I <sub>L (MAX)</sub>	V <sub>BRITE</sub> = 2.2 V <sub>DC</sub> , SLEEP = Logic High, V <sub>IN</sub> = 12V, V <sub>OUT</sub> = 400V <sub>RMS</sub>	6.5	7.0	7.5	mA
Minimum Lamp Current	I <sub>L (MIN)</sub>	$V_{BRITE} = 0.0 V_{DC}$ , $\overline{SLEEP} = Logic High, V_{IN} = 12V, V_{OUT} = 400V_{RMS}$	==	1.3	O.E.	mA <sub>RM</sub>
I <sub>OUT</sub> Regulation vs. V <sub>IN</sub>		$I_{OUT}$ set to 5mA <sub>RMS</sub> , $V_{OUT} = 400V_{RMS}$ , $10.0 \le V_{IN} \le 14V_{DC}$	4.75	5.00	5.25	mA
Lamp Start Voltage	V <sub>LS</sub>	0°C < T <sub>A</sub> < 60°C	1300	100	35	V <sub>RMS</sub>
Operating Frequency	fo	$V_{BRITE} = 2.2V_{DC}$ , $\overline{SLEEP} = Logic High, V_{IN} = 12V$	The same	50	- 05	KHz
Brightness Control			NEW Y		-125	-
Input Current	IBRITE	$V_{BRITE} = OV_{DC}$	多天	-200	-1000	nA
Input Voltage for Max. Lamp Current	V <sub>c</sub>	I <sub>O (LAMP)</sub> = 100%	2.0	2.1	2.2	VDC
SLEEP Input				200	-84	12.7
Input Logic 1	V <sub>IH</sub>		2.2		5.5	V <sub>DC</sub>
Input Logc 0	V <sub>IL</sub>		0		0.8	V <sub>DC</sub>
Input Current	I <sub>IN</sub>	$V_{\overline{SLEEP}} = 5V_{DC}$ , $V_{IN} = 20V_{DC}$ (Note 1)	W.L.	-150	100	μA <sub>DC</sub>
Voltage Reference	ş					
Output Voltage	V <sub>REF</sub>	0 < I <sub>REF</sub> < 500μA	2.40	2.50	2.60	V <sub>DC</sub>
Output Current	I <sub>REF</sub>	Computer 2	250	500		μA <sub>DC</sub>
Power Characteristics		E religioso				
Sleep Current	I <sub>IN (MIN)</sub>	$V_{IN} = 5V_{DC}$ , $\overline{SLEEP} = Logic 0$	-	3	10	μA <sub>DC</sub>
Electrical Efficiency (calculated values)	η	$V_{IN} = 12V_{DC}$ , $I_{O(LAMP)} = 5mA_{RMS}$		90		%

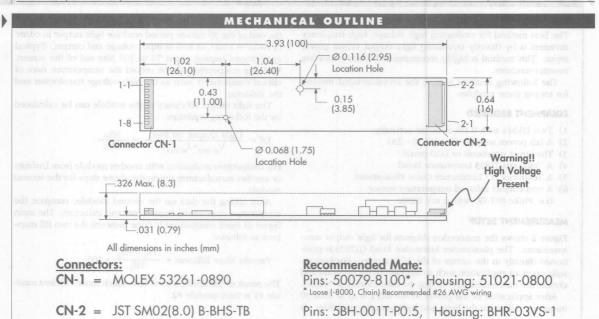
Note 1:  $\overline{\text{SLEEP}}$  pin is pulled up to  $V_{IN}$  through a  $100 \text{k}\Omega$  resistor and is clamped to not exceed  $10 V_{DC}$  if  $V_{IN} > 10 V_{DC}$ 



#### 12V CCFL INVERTER MODULES

#### PRELIMINARY DATA SHEET

	his sais	FUNCTIONAL PIN DESCR	IPTION
Conn.	Pin	Description	
CN1			
CN1-1 CN1-2	V <sub>IN</sub>	Input voltage. (+10 to +14V <sub>DC</sub> )	
CN1-3 CN1-4	GND 99	Power supply return.	100X SALE AND ENTE
CN1-5	SLEEP	Logical high on this pin enables inverter operation. Lo the lamp. A floating input is sensed as a logical high a modulate lamp intensity by varying duty cycle.	
CN1-6	BRITE	Brightness control input. Apply 0.0 to 2.2 volts DC to linearly with input voltage. Open circuit or 2.2V gives	
CN1-7	AGND	Brightness control signal return. For best results do not	run power supply current return through this pin.
CN1-8	V <sub>REF</sub>	Reference Voltage Output. 2.5V @ 500µA max. For us	se with external dimming circuit.
CN2		SengOff Educated Page 100 page	
CN2-1	LAMP HI	High voltage connection to high side of lamp. Connect connect to ground.	t to lamp terminal with shortest lead length. Do no
CN2-2	LAMP LO	High voltage connection to low side of lamp. Connect connect to ground.	t to lamp terminal with longer lead length. Do no



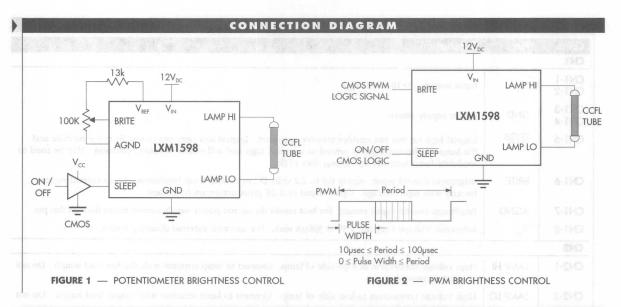
Note: All samples are equipped with connector mates and cable.



# LXM1598-01

#### 12V CCFL INVERTER MODULES

#### PRELIMINARY DATA SHEET



#### FFFICIENCY MEASUREMENT SETUR

#### INTRODUCTION

The best method for evaluating high voltage, high frequency inverters is by directly measuring light output versus power input. This method is highly recommended when evaluating inverter modules.

The following sections outline the recommended method for testing these modules.

#### **EQUIPMENT REQUIRED**

- 1) Two DVM's with 0.1% or better accuracy.
- 2) A lab power supply. (0 20V, 0 2A)
- 3) The target notebook or LCD panel.
- 4) A Tektronix J1803 Luminance Head.
- 5) A Tektronix J17 Luminance Color Photometer.
- 6) A non-contact infrared temperature sensor (i.e. Fluke 80T-IR) with a mV meter.

#### MEASUREMENT SETUP

Figure 2 shows the connection diagram for light output measurements. The photometer luminance head (J1803) is positioned directly in the center of the LCD screen. For best results open an application such as the Paintbrush program and choose the maximized view so that the entire screen is "white".

After application of the power to the CCFL wait at least 30 minutes to allow for the lamp and light output to stabilize. At

the end of the 30 minute period read the light output in  $cd/m^2$  (1  $cd/m^2$  = 1 Nit), as well as input voltage and current. Typical applications require about 70 to 100 Nits out of the screen. With the temperature probe record the temperature rises of critical components such as the high voltage transformer and the inductor.

The light output efficiency of the module can be calculated by the following equation:

$$Eff = \frac{Light\ Output\ (in\ Nits)}{V_{IN\ (DC)} * I_{IN\ (DC)}} = \frac{Nits}{Watt}$$

For competitive evaluation with another module from Linfinity or another manufacturer repeat the above steps for the second module.

After taking the data on the second module, compare the temperature rises on the transformer and inductors. The main figure of merit comparison is done between the two Eff numbers as follows:

Percent More Efficient = 
$$\frac{\text{Eff}_1 - \text{Eff}_2}{\text{Eff}_2} * 100$$

The result of the above shows how much more efficient module #1 is than module #2.



LXM1598-01

# 12V CCFL INVERTER MODULES

PRELIMINARY DATA SHEET

#### EFFICIENCY MEASUREMENT SETUP (continued)

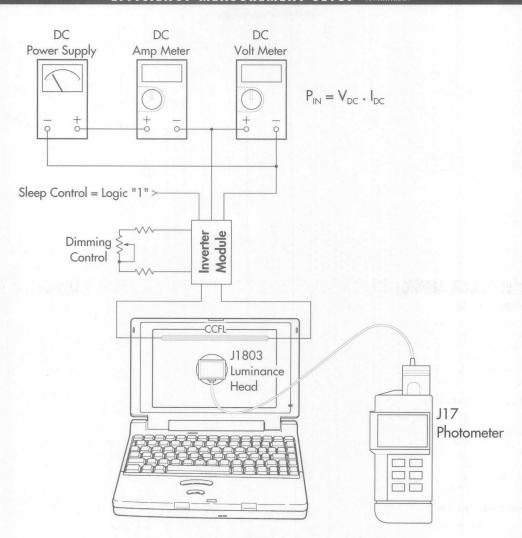
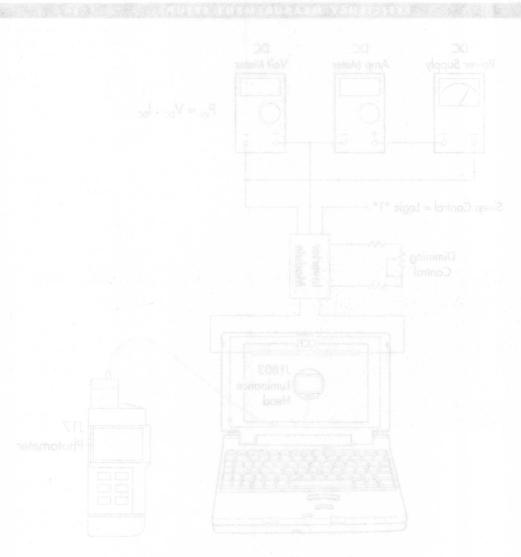


FIGURE 2 — LIGHT OUTPUT MEASUREMENT SETUP

# Notes

PRELIMINARY BATA SHEET



SOUTH WEARING AND THE SETUP.





PENTIUM® PRO VRM MODULE

THE INFINITE POWER OF INNOVATION PRELIMINARY SPECIFICATION

#### DESCRIPTION

The LXM1600/1600A-xx series of DC/DC converters are Voltage Regulator Modules (VRM) which are specifically designed to meet or exceed the Pentium Pro VRM electrical specification as well as its mechanical outline. The LXM1600-xx is guaranteed to deliver a minimum current of 11.2A while the LXM1600A-xx is capable of 12.4A for higher speed processor applications. These converters maintain a total tolerance of ±5% maximum, which includes load and line regulation, temperature stability, inital accuracy, load transient and ripple and noise. One of the main features of these converters is their ability to program the output voltage from 2 to 3.5V using a 4-bit word from the processors, providing automatic voltage adjustment for each individual processor. Other features include high efficiency, short-circuit protection, over-voltage protection, under-voltage detection, soft start and logic level output enable functions.

The LXM1600/1600A-05 powers the processor using the 5V supply as the input power and 12V for the control bias. The LXM1600/1600A-12 powers the processor using only the 12V supply and does not need a separate voltage for the control bias (see Block Diagram below). The LXM1600A-12 is primarily used for multiple processor applications, such as quad processor servers, where 5V supplies may not have the needed current capability.

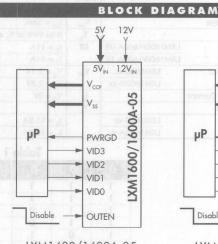
#### KEY FEATURES

- GUARANTEED > 12.4A (LXM1600A-xx)
- GUARANTEED > 11.2A (LXM1600-xx)
- TOTAL OUTPUT TOLERANCE OF LESS THAN +5%

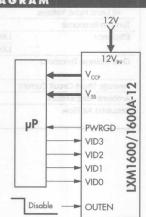
Includes: Line & load regulation, temperature stability, initial accuracy, load transient and ripple & noise.

- ADJUSTABLE OUTPUT VOLTAGE USING A FOUR-BIT WORD (See Table 1)
- OVER-VOLTAGE DETECTION CROWBARS THE OUTPUT VOLTAGE IN THE EVENT OF PASS TRANSISTOR FAILURE - 100% PROCESSOR PROTECTION
- ☐ HIGH EFFICIENCY 85% (TYP.)
- POWER GOOD SIGNAL INDICATES LOW **OUTPUT VOLTAGE**
- SOFT START ELIMINATES TURN ON **OVERSHOOT**
- SHORT-CIRCUIT PROTECTION
- □ OUTPUT ENABLE /SHUTDOWN

# **MODULE PHOTO**



LXM1600/1600A-05 IN A 5V SUPPLY APPLICATION



LXM1600/1600A-12 IN A 12V SUPPLY APPLICATION

MODUL	E ORDER INFO	RMATION
Part #	Input	I <sub>MAX</sub>
LXM1600-05	5V	11.2A
XM1600A-05	5V	12.4A
LXM1600-12	12V	11.2A
LXM1600A-12	12V	12.4A

FOR FURTHER INFORMATION CALL (714) 898-8121

#### PENTIUM® PRO VRM MODULE

#### PRELIMINARY SPECIFICATION

				LXM	1600/1600	A-xx	
Parameter		Symbol	Test Conditions	Min.			Units
Input Voltage L	XM1600/1600A-05	V <sub>IN</sub>	or evenues called features in	4.75	5 / 7 /	5.25	V
Fig. 1	XM1600/1600A-12	rion	se efficiency slienshould protect	11.4	12	12.6	V
Total Output Voltage Tolerance	LXM1600-xx	V <sub>o</sub>	<ul> <li>a- over-voluge protection, unde</li> </ul>	2.945	3.1	3.255	V
	LXM1600A-xx	lavel	e derectique, soft statet apul logaci	3.135	3.3	3.465	V
Includes: Initial Accuracy	CONTRACTOR		I <sub>o</sub> = 0.3A, T <sub>A</sub> = 25°C	cardeed to	±0.6	DO STRIX	%
Load Regulation	LXM1600-xx	all may	I <sub>o</sub> = 0.3A to 11.2A	est of the Est	15	130 6 15	mV
	LXM1600A-xx	call su v	I <sub>o</sub> = 0.3A to 12.4A	ale stitus sie	15	the D.S	mV
Line Regulation	They	lesino.	0.95V <sub>IN</sub> to 1.05V <sub>IN</sub>	Discussion.	1994	Buth rod a	mV
Temp. Stability	200	BEWOO.	10 to 60°C	esta resvo	16	. enorteo	mV
Load Transient	LXM1600-xx	70.1	$I_{\odot} = 0.3A \text{ to } 11.2A, V_{IN} = 5V$	W CS 10 50	90	OT BONE	mV
	LXM1600A-xx	DENERGI	$I_{o} = 0.3A$ to 12.4A, $V_{iN} = 5V$	and peopless.	95	i i nilan	mV
Output Ripple & Noise		edla w	I <sub>o</sub> = 5A	SELECTION OF SELECT	12	ाम्बार्ग्य व	mV
Output Current	Max. 1600-xx	I <sub>o</sub>	V <sub>0</sub> = 3.1V	11.2	11.8	21103045	A
	Max. 1600A-xx	1022550	V <sub>o</sub> = 3.1V	12.4	12.6	PIT PISH S	A
	Minimum	1400000000	m chiny sit above, occurrence of	11211 1122 2 1931	evillen ov	0	A
Power Good Threshold	OHS 20	V <sub>THPG</sub>	A CONTRACTOR OF THE PROPERTY O		0.93V <sub>SET</sub>		V
Power Good Output LO Resista	nce	R <sub>LOPG</sub>	OUTEN = LO		5		Ω
Output Enable		OUTEN		.119			N. F.
LO Level Input Voltage		VoL	I <sub>OL</sub> = 1mA		NO CON	0.8	٧
HI Level Input Voltage		V <sub>OH</sub>	I <sub>OH</sub> = 1mA	2			V
Turn-on Response	V.A.	T <sub>R</sub>	0 to 99% of Vo after Vin reaches 90%			10	ms
Efficiency L	XM1600/1600A-05	Eff	I <sub>o</sub> = 11A		85		%
L. C.	XM1600/1600A-12		I <sub>o</sub> = 11A		80		%
Over-Voltage Threshold	LXM1600-xx	Vov	V <sub>O</sub> = 3.1V		3.66		٧
V removedib	LXM1600A-xx	C V Intel	V <sub>O</sub> = 3.3V		3.85		٧
Average Short-Circuit Current	625	I <sub>sc</sub>	$V_{o} = 0V$		2	27 3	A
Ambient Temperature	1.7	T <sub>A</sub>		0		60	°C
Required Air Flow	LXM1600-xx		I <sub>o</sub> = 11.2A	100			LFM

		Table	1	
D <sub>3</sub>	D <sub>2</sub>	D,	D <sub>o</sub>	V <sub>SET</sub> (V)
1	1	1	1	2 -
1	1	1	0	2.1
1	1	0	1	2.2
1	1 -	0	0	2.3
1	0	1	1	2.4
0-460	0	1	0	2.5
Land	0	0	1	2.6
1	0	0	0	2.7
0	1	1	1	2.8
0	1	1	0	2.9
0	1	0	1	3.0
0	1	0	0	3.1
0	0	1 94	1	3.2
0	0	1 1	0	3.3
0	0	0	1	3.4
0	0	0	0	3.5

I<sub>0</sub> = 12.4A

LXM1600A-xx

Note: 0 ≡ Processor pin connected to ground.
1 ≡ Processor pin Open or pulled High externally by system design to detect a socket

with no processor.

200

LFM

Output voltage to microprocessor

Output voltage return

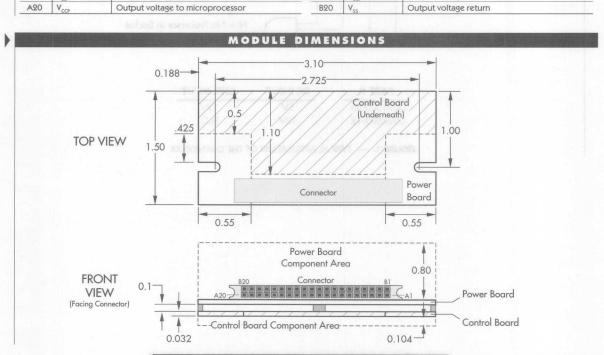
#### PENTIUM® PRO VRM MODULE

#### PRELIMINARY SPECIFICATION

Pin #	Ref. Desig.	Description	Pin #	Ref. Desig.	Description
A1	5V <sub>IN</sub>	5V Input Power (not needed for LXM1600/1600A-12)	B1	5V <sub>IN</sub>	5V Input Power (not needed for LXM1600/1600A-12)
A2	5V <sub>IN</sub>	5V Input Power (not needed for LXM1600/1600A-12)	B2	5V <sub>IN</sub>	5V Input Power (not needed for LXM1600/1600A-12)
A3	5V <sub>IN</sub>	5V Input Power (not needed for LXM1600/1600A-12)	В3	5V <sub>IN</sub>	5V Input Power (not needed for LXM1600/1600A-12)
A4	12V <sub>IN</sub>	12V Input Power	B4	12V <sub>IN</sub>	12V Input Power
A5	Reserved	This pin is reserved for future applications	B5	Reserved	This pin is reserved for future applications
A6	Reserved	This pin is reserved for future applications	В6	OUTEN	A TTL input that disables output when it switches to LO state
A7	VIDO	Bit 0 of the 4-bit input (see Table 1)	B7	VID1	Bit 1 of the 4-bit input (see Table 1)
A8	VID2	Bit 2 of the 4-bit input (see Table 1)	B8	VID3	Bit 3 of the 4-bit input (see Table 1)
A9	UP#	This pin is not connected internally	В9	PWRGD	An open collector output that switches LO when output is below the specified range
A10	V <sub>CCP</sub>	Output voltage to microprocessor	B10	V <sub>SS</sub>	Output voltage return
A11	V <sub>ss</sub>	Output voltage return	B11	V <sub>CCP</sub>	Output voltage to microprocessor
A12	V <sub>CCP</sub>	Output voltage to microprocessor	B12	V <sub>ss</sub>	Output voltage return
A13	V <sub>ss</sub>	Output voltage return	B13	V <sub>CCP</sub>	Output voltage to microprocessor
A14	V <sub>CCP</sub>	Output voltage to microprocessor	B14	V <sub>ss</sub>	Output voltage return
A15	V <sub>ss</sub>	Output voltage return	B15	V <sub>CCP</sub>	Output voltage to microprocessor
A16	V <sub>CCP</sub>	Output voltage to microprocessor	B16	V <sub>ss</sub>	Output voltage return
A17	V <sub>ss</sub>	Output voltage return	B17	V <sub>CCP</sub>	Output voltage to microprocessor
A18	Vccp	Output voltage to microprocessor	B18	Vss	Output voltage return

B19

B20



Pentium is a registered trademark of Intel Corporation.

A19

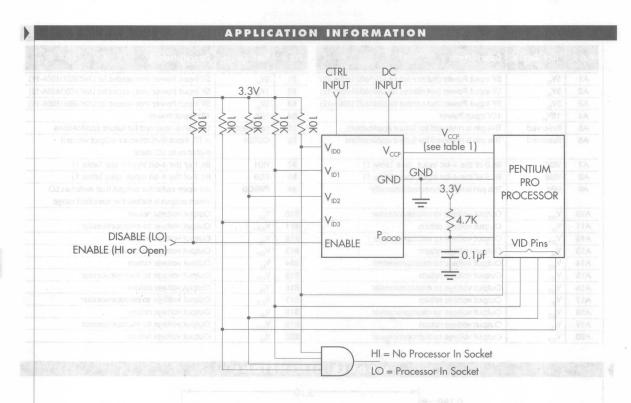
A20

Output voltage return

Output voltage to microprocessor

#### PENTIUM® PRO VRM MODULE

#### PRELIMINARY SPECIFICATION



PART #	DC INPUT	CTRL INPUT
LXM1600-05	5V	12V
LXM1600-12	12V	N.C.

FIGURE 1. — TYPICAL APPLICATION OF THE LXM1600-XX





#### UNDERVOLTAGE SENSING CIRCUIT

THE INFINITE POWER OF INNOVATION PRODUCTION DATA SHEET

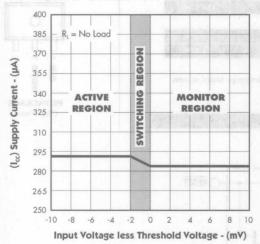
#### DESCRIPTION

The MC34064 is an undervoltage sensing circuit designed specifically for use as a reset controller in microprocessor-based systems. It offers the designer an economical, space-efficient solution for low supply voltage detection when used in combination with a single pullup resistor. Adding one capacitor offers the functionality of a programmable delay time after power returns. The 34064 consists of a temperature stable reference comparator with hysteresis, high-current clamping diode and open

collector output stage capable of sinking up to 60mA. The MC34064's RESET output is specified to be fully functional at V<sub>IN</sub>=1V. A major improvement over competing products is the glitch-free supply current during undervoltage detection. Competing products demand a step function increase in operating current during the time that you least want or need it... during power loss. See Product Highlight below.

#### PRODUCT HIGHLIGHT

SUPPLY CURRENT VS. INPUT VOLTAGE



#### KEY FEATURES

- MONITORS 5V SUPPLIES. (V\_= 4.6V typ)
- OUTPUTS FULLY DEFINED AT V., = 1V. (See Figure 1)
- GLITCH-FREE SUPPLY CURRENT DURING SWITCHING. (See Product Highlight)
- ☐ ULTRA-LOW SUPPLY CURRENT (500µA max)
- ☐ TEMPERATURE COMPENSATED L. FOR EXTREMELY STABLE CURRENT CONSUMPTION.
- IN UP RESET FUNCTION PROGRAMMARIE WITH 1 EXTERNAL RESISTOR AND CAPACITOR
- ☐ COMPARATOR HYSTERESIS PREVENTS OUTPUT OSCILLATION.
- ELECTRICALLY COMPATIBLE WITH MOTOROLA MC34064.
- PIN-TO-PIN COMPATIBLE WITH MOTOROLA MC34064/MC34164.

#### **APPLICATIONS**

- ALL MICROPROCESSOR OR MICROCONTROLLER DESIGNS USING 5V SUPPLIES.
- SIMPLE 5V UNDERVOLTAGE DETECTION.

	PACKAGE OR	DER INFORMA	ATION
T <sub>A</sub> (°C)	DM Plastic SOIC 8-pin	LP Plastic TO-92 3-pin	PK Plastic SOT-89 3-pin
0 to 70	MC34064DM	MC34064LP	MC34064PK
-40 to 85	MC33064DM	MC33064LP	MC33064PK
-55 to 125	_	_	_ 0

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. MC34064DMT)

#### ABSOLUTE MAXIMUM RATINGS (Note 1)

Note 1. Values beyond which damage may occur. All voltages are specified with respect to ground, and all currents are positive into the specified terminal.

#### **PACKAGE PIN OUTS**

RESET 1 8 N.C.

V<sub>IN</sub> 2 7 N.C.

N.C. 3 6 N.C.

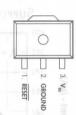
GROUND 4 5 N.C.

DM PACKAGE (Top View)



LP PACKAGE

(Top View)



PK PACKAGE (Top View)

#### THERMAL DATA

#### DM PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT,  $\theta_{_{JA}}$  165°C/W

LP PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT,  $\theta_{_{JA}}$  156°C/W

PK PACKAGE:

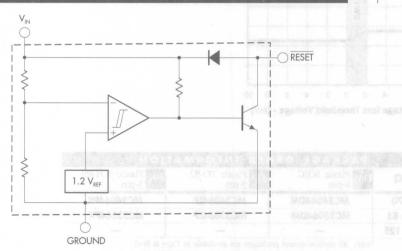
THERMAL RESISTANCE-JUNCTION TO TAB,  $\theta_{_{JT}}$  35°C/W

THERMAL RESISTANCE-JUNCTION TO AMBIENT,  $\theta_{_{JA}}$  71°C/W

Junction Temperature Calculation:  $T_{J} = T_{A} + (P_{D} \times \theta_{JA})$ .

The  $\theta_D$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow

#### BLOCK DIAGRAM



#### UNDERVOLTAGE SENSING CIRCUIT

#### PRODUCTION DATA SHEET

Parameter	Symbol	Recommended Operating Conditions			
Falallietei	Sylliooi	Min.	Тур.	Max.	Units
Input Supply Voltage	V <sub>IN</sub>	SWITT STATE	DV TISTIN TIPE	6.5	٧
RESET Output Voltage	V <sub>out</sub>		6.5	ov filodo di colove	٧
Clamp Diode Forward Current	I <sub>F</sub>		50mA		
Operating Ambient Temperature Range:			SIGNALIUV IS	KES INVOICE W	21 15
MC34064	TA	0	NOT AT INSTITUTED IN	70	°C
MC33064 DA 1994 TREES ACRES AC	T <sub>A</sub>	-40	THE VEHICLE OF THE PARTY OF THE	85	°C

#### **ELECTRICAL CHARACTERISTICS**

(Unless otherwise specified, these specifications apply over the operating ambient temperatures of  $0^{\circ}\text{C} \le \text{T}_{A} \le 70^{\circ}\text{C}$  for the MC34064 and  $-40^{\circ}\text{C} \le \text{T}_{A} \le 85^{\circ}\text{C}$  for the MC33064. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	MC34064/MC33064			Units
Parameter	Symool	lest Conditions	Min.	Тур.	Max.	Units
Comparator Section						
Threshold Voltage			HOLESTON - V	EQ MON	ADARCE.	24.
High State Output	V <sub>T+</sub>	V <sub>IN</sub> Increasing — 4V to 5V	4.5	4.61	4.7	V
Low State Output	V <sub>T</sub> .	V <sub>IN</sub> Decreasing — 5V to 4V	4.5	4.59	4.7	V
Hysteresis	V <sub>H</sub>		0.01	0.02	0.05	V
RESET Output Section						
Output Low Level Saturation Voltage	7 7 7 7	V <sub>IN</sub> = 4.0V, I <sub>OL</sub> = 8.0mA			1.0	V
	VoL	$V_{IN} = 4.0V, I_{OL} = 2.0mA$			0.4	V
		$V_{IN} = 1.0V, I_{OL} = 0.1 \text{mA}$			0.1	٧
Output Low Level Current	loL	$V_{IN} = V_{OUT} = 4.0V$	10	27	60	mA
Output Off-State Leakage	I <sub>OH</sub>	$V_{IN} = V_{OUT} = 5.0V$		0.02	0.5	μА
Clamp Diode Forward Voltage	V <sub>F</sub>	Pin 1 to pin 2, I <sub>F</sub> = 10mA	0.6	0.9	1.2	٧
Total Device						
Supply Current	I <sub>cc</sub>	$V_{IN} = 5.0V$		390	500	μА

#### TRANSIENT IMMUNE UNDERVOLTAGE SENSING CIRCUIT

PRODUCTION DATA SHEET

	RES PE	GRA	PH / CI	URVE INDEX	)		E STATE	FI	GURE INDEX
EIGI	JRE#	Cl	naracter	istic Curves		FIG	URE#	App	olication Circuits
1.	100	NTAGE an	d DESET OU	TPUT VOLTAGE vs. TIME				GE MICEC	DPROCESSOR RESET
W	POWER-L			TPOT VOLIAGE VS. TIME					
2.			Ami	20					O OFF WHEN BATTERY REACHES BELOW 4.3V
3.			SET VOLTAG				VOLTAGE M		
4.	RESET OL	JTPUT VOI	TAGE vs. IN	PUT VOLTAGE		18. MOSFET LOW VOLTAGE GATE DRIVE PROTECTION			
5.	THRESHO	LD VOLTA	GE vs. TEM	PERATURE		19.		GE MICRO	PROCESSOR RESET with ADDITIONAL
6.	THRESHO	LD HYSTE	RESIS vs. TE	MPERATURE		HYSTERESIS STATES OF THE PROPERTY OF THE PROPE			
7.	SUPPLY CURRENT vs. INPUT VOLTAGE  20. SOLAR POWERED BATTERY CHARGER				ITERY CHARGER				
8.	SUPPLY CI	JRRENT VS	. TEMPERAT	URE		I THE			
9.	LOW LEV	EL OUTPU	T CURRENT	s TEMPERATURE		Charles and			
10.	LOW LEV	EL OUTPU	T SATURATIO	ON VOLTAGE VS. TEMPERAT	URE				
11.				ON VOLTAGE vs. TEMPERAT		School of			
12.				AGE vs. FORWARD CURRENT					
13.	PROPAGA	TION DEL	AY — HIGH	to LOW					
14.	PROPAGA	TION DEL	AY—LOW	to HIGH					
						V1			

#### UNDERVOLTAGE SENSING CIRCUIT

PRODUCTION DATA SHEET

FIGURE 1. — INPUT VOLTAGE and RESET OUTPUT
VOLTAGE vs. TIME

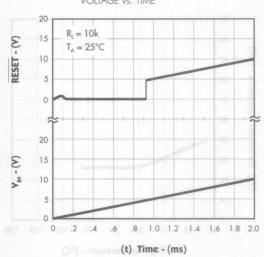


FIGURE 2. — POWER-UP RESET VOLTAGE

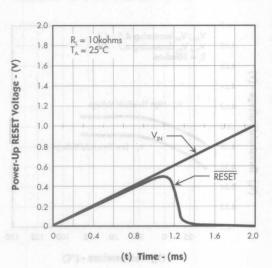


FIGURE 3. — POWER-DOWN RESET VOLTAGE

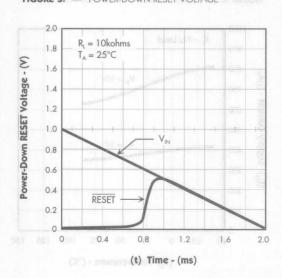
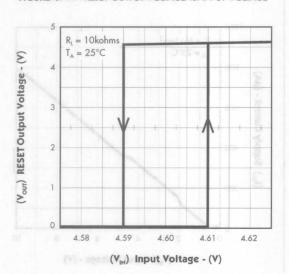


FIGURE 4. — RESET OUTPUT VOLTAGE VS. INPUT VOLTAGE



#### PRODUCTION DATA SHEET

FIGURE 5. — THRESHOLD VOLTAGE VS. TEMPERATURE

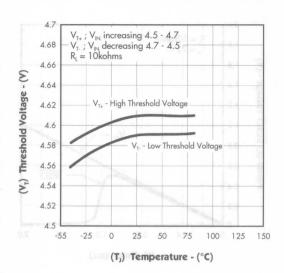


FIGURE 6. — THRESHOLD HYSTERESIS vs. TEMPERATURE

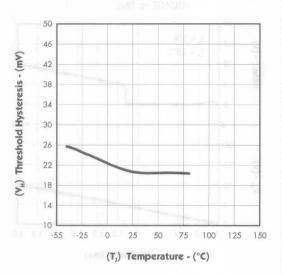


FIGURE 7. — SUPPLY CURRENT VS. INPUT VOLTAGE

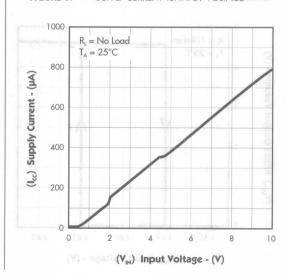
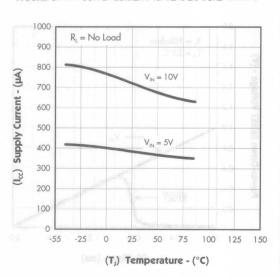


FIGURE 8. — SUPPLY CURRENT VS. TEMPERATURE



#### UNDERVOLTAGE SENSING CIRCUIT

#### PRODUCTION DATA SHEET

FIGURE 9. — LOW LEVEL OUTPUT CURRENT

VS. TEMPERATURE

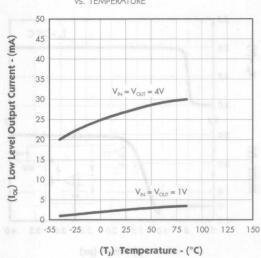


FIGURE 10. — LOW LEVEL OUTPUT SATURATION VOLTAGE
VS. TEMPERATURE

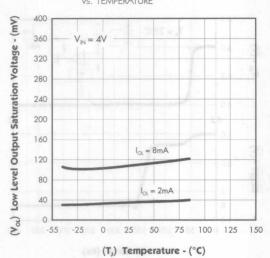


FIGURE 11. — LOW LEVEL OUTPUT SATURATION VOLTAGE vs. TEMPERATURE

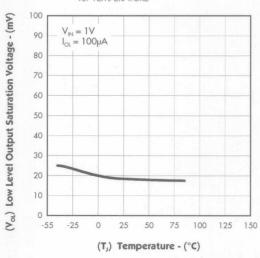
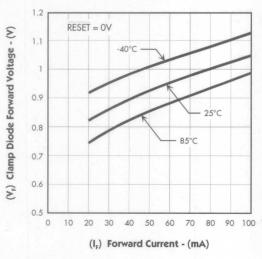


FIGURE 12. — CLAMP DIODE FORWARD VOLTAGE vs. FORWARD CURRENT



#### TRANSIENT IMMUNE UNDERVOLTAGE SENSING CIRCUIT

#### PRODUCTION DATA SHEET

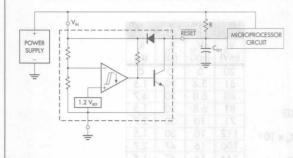
# CHARACTERISTIC CURVES FIGURE 13. — PROPAGATION DELAY — HIGH to LOW FIGURE 14. — PROPAGATION DELAY — LOW to HIGH $T_A = 25^{\circ}C$ $T_A = 25^{\circ}C$ 5.0 5.0 4.5 4.5 4.0 4.0 5.0 5.0 3.0 3.0 1.0 1.0 0 0 0 50 100 150 200 250 300 350 0 .5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 (t) Time - (ns) (t) Time - (μs)

#### Undervoltage Sensing Circuit

#### PRODUCTION DATA SHEET

#### TYPICAL APPLICATION CIRCUITS

FIGURE 15. — LOW VOLTAGE MICROPROCESSOR RESET



A time delayed reset can be accomplished with the addition of  $C_{\text{DLY}}$ . For systems with extremely fast power supply rise times (< 500ns) it is recommended that the  $RC_{\text{DLY}}$  time constant be greater than 5.0µs.  $V_{\text{TH(MPL)}}$  is the microprocessor reset input threshold.

$$t_{DLY} = R C_{DLY} In \left[ \frac{1}{1 - \frac{V_{TH(MPU)}}{V_{IN}}} \right]$$

FIGURE 17. — VOLTAGE MONITOR

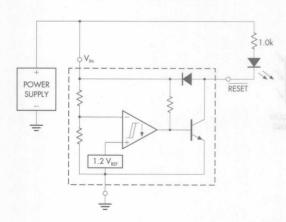
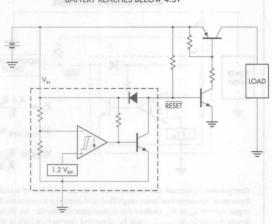
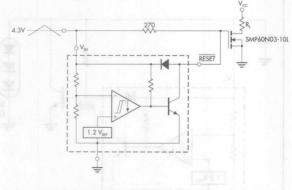


FIGURE 16. — SWITCHING THE LOAD OFF WHEN BATTERY REACHES BELOW 4.3V



#### FIGURE 18. — MOSFET LOW VOLTAGE GATE DRIVE PROTECTION



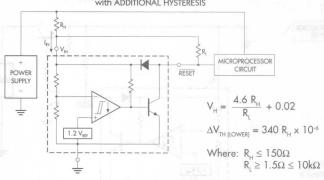
Overheating of the logic level power MOSFET due to insufficient gate voltage can be prevented with the above circuit. When the input signal is below the 4.6 volt threshold of the MC34064, its output grounds the gate of the  $1.^{2}\,\mathrm{MOSFET}.$ 

#### TRANSIENT IMMUNE UNDERVOLTAGE SENSING CIRCUIT

#### PRODUCTION DATA SHEET

#### TYPICAL APPLICATION CIRCUITS (Cont'd.

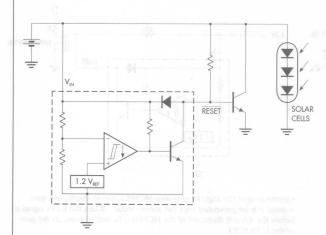
FIGURE 19. — LOW VOLTAGE MICROPROCESSOR RESET with ADDITIONAL HYSTERESIS

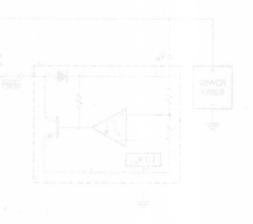


Comparator hysteresis can be increased with the addition of resistor  $R_{H^{\prime}}$ . The hysteresis equation has been simplified and does not account for the change of input current  $I_{IN}$  as  $V_{CC}$  crosses the comparator threshold. An increase of the lower threshold  $\Delta V_{TH (LOWER)}$  will be observed due to  $I_{IN}$  which is typically 340µA at 4.59V. The equations are accurate to  $\pm 10\%$  with  $R_{H}$  less than  $150\Omega$  and  $R_{L}$  between  $1.5k\Omega$  and  $10k\Omega$ .

TEST DATA					
(mV)	ΔV <sub>TH</sub> (mV)	$R_H$	$R_{L}$ $(\Omega)$		
20	0	0	0		
51	3.4	10	1.5		
40	6.8	20	4.7		
81	6.8	20	1.5		
71	10	30	2.7		
112	10	30	1.5		
100	16	47	2.7		
164	16	47	1.5		
190	34	100	2.7		
327	34	100	1.5		
276	51	150	2.7		
480	51	150	1.5		

#### FIGURE 20. — SOLAR POWERED BATTERY CHARGER





3 V Undervoltage Sensing Circuit

THE INFINITE POWER OF INNOVATION PRODUCTION DATA SHEET

#### DESCRIPTION

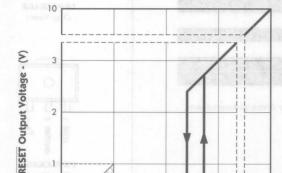
The MC33164-3 and MC34164-3 are undervoltage sensing circuits designed specifically for use as reset controllers in microprocessor-based systems. They offer the designer an economical, space efficient solution for low supply voltage detection when used in combination with a single pull-up resistor. Adding one capacitor offers the functionality of a programmable delay time after power

returns. The MC33164-3 and MC34164-3 consist of a temperature stable reference comparator with hysteresis, high-current clamping diode and an open collector output stage capable of sinking more than 6mA over the full temperature range. The MC33164-3 and MC34164-3's RESET output is specified to be fully functional at  $V_{IN} \ge 1V$ . See Product Highlight below.

#### KEY FEATURES

- **■** MONITORS +3.3V SUPPLIES  $(V_r = 2.7V \text{ typ})$
- OUTPUTS FULLY DEFINED AT V<sub>IN</sub> ≥ 1V (See Product Highlight)
- ULTRA-LOW SUPPLY CURRENT (13µA max)
- ☐ TEMPERATURE COMPENSATED I. FOR EXTREMELY STABLE CURRENT CONSUMPTION
- UP RESET DELAY PROGRAMMABLE WITH 1 EXTERNAL RESISTOR AND CAPACITOR
- COMPARATOR HYSTERESIS PREVENTS OUTPUT OSCILLATION (60mV typ.)
- ELECTRICALLY COMPATIBLE WITH MOTOROLA MC34164-3
- PIN-TO-PIN COMPATIBLE WITH MOTOROLA MC34064 / MC34164

#### PRODUCT HIGHLIGHT RESET OUTPUT VS. INPUT VOLTAGE



Undefined

#### Input Voltage - (V)

#### **APPLICATIONS**

- ALL MICROPROCESSOR OR MICROCONTROLLER DESIGNS USING 3V/3.3V SUPPLIES
- SIMPLE 3V/3.3 UNDERVOLTAGE DETECTION

#### PACKAGE ORDER INFORMATION

T <sub>A</sub> (°C)	DM Plastic SOIC 8-pin	LP Plastic TO-92 3-pin	PK Plastic SOT-89 3-pin
0 to 70	MC34164-3DM	MC34164-3LP	MC34164-3PK
-40 to 85	MC33164-3DM	MC33164-3LP	MC33164-3PK

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. MC34164-3DMT)

#### 3 V Undervoltage Sensing Circuit

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Note 1. Values beyond which damage may occur. All voltages are specified with respect to ground, and all currents are positive into the specified terminal.

#### THERMAL DATA

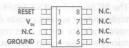
#### DM PACKAGE:

165°C/W
PARTIE DE VAN DE LA COMPANIE DE LA C
156°C/W
35°C/W
71°C/W

Junction Temperature Calculation:  $T_J = T_A + (P_D \times \theta_{JA})$ .

The  $\theta_{J_A}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow

#### PACKAGE PIN OUTS

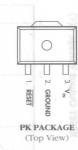


DM PACKAGE

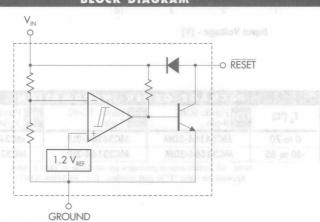
(Top View)



(Top View)



#### BLOCK DIAGRAM





# 3 V Undervoltage Sensing Circuit

#### PRODUCTION DATA SHEET

Paramatan	Cumbal	Recommended Operating Conditions			
Parameter	Symbol	Min.	Тур.	Max.	Units
Input Supply Voltage	V <sub>IN</sub>	1 BOAT	OV TUSTINO THE	20 30 10 OV TUS	٧
RESET Output Voltage	V <sub>out</sub>	-0.3		10	V
Clamp Diode Forward Current (Note 3)	I <sub>F</sub>		The contract S	100	mA
Operating Ambient Temperature Range:			ae/nulliv i	BESN KIN CAL-XS WI	1 15
MC34164-3	TA	0		70	°C
MC33164-3	TA	-40		ATIOV 85	°C

Note 2. Range over which the device is guaranteed functional.

Note 3. Maximum junction temperature ratings must be observed.

#### **ELECTRICAL CHARACTERISTICS**

(Unless otherwise specified, these specifications apply over the operating ambient temperatures of  $0^{\circ}\text{C} \leq T_{_{A}} \leq 70^{\circ}\text{C}$  for the MC34164-3 and -40°C  $\leq T_{_{A}} \leq 85^{\circ}\text{C}$  for the MC33164-3. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions		MC33164-3 / 34164-3		
raidilletei	Symoon			Тур.	Max.	Units
Comparator Section						
Threshold Voltage		1 Dil 1 O/ W	1	AND THE REAL PROPERTY.		
High State Output	V <sub>T+</sub>	V <sub>IN</sub> Increasing — 2.4V to 3.5V	2.55	2.71	2.8	٧
Low State Output	V <sub>T</sub> .	V <sub>IN</sub> Decreasing — 3.5V to 2.4V	2.55	2.65	2.8	٧
Hysteresis	V <sub>H</sub>	$(I_{OL} = 100 \mu A)$	0.03	0.06		٧
RESET Output Section						
Output Low Level Saturation Voltage		$V_{IN} = 2.4V, I_{OL} = 8.0 \text{mA}$		0.15	1.0	٧
	VoL	V <sub>IN</sub> = 2.4V, I <sub>OL</sub> = 1.0mA		0.04	0.4	٧
		$V_{IN} = 1.0V, I_{OL} = 0.25mA$		0.02	0.3	٧
Output Low Level Current	I <sub>OL</sub>	$V_{IN}$ , RESET = 2.4V	6.0	24	40	mA
Output Off-State Leakage	I <sub>OH</sub>	$V_{IN}$ , $\overline{RESET} = 3.0V$		.02	0.5	μA
		$V_{IN}$ , $\overline{RESET} = 10V$		.02	1.0	μА
Clamp Diode Forward Voltage	V <sub>F</sub>	Pin 1 to pin 2, I <sub>F</sub> = 5mA	0.6	0.75	1.0	٧
Total Device						
Supply Current	I <sub>cc</sub>	$V_{IN} = 3.0V$	1	9	13	μА
		$V_{BA} = 6.0V$		21	30	μА

# 3 V Undervoltage Sensing Circuit

#### PRODUCTION DATA SHEET

		GRA	PH / C	CURVE INDEX			FI	GURE INDEX
FIGU	DF #	Ch	naracte	ristic Curves	FIG	URE#	Арр	lication Circuits
1. 2. 3. 4.	INPUT VO POWER-U POWER-D RESET OU	P RESET VOI	OLTAGE SET VOLTA JAGE vs.	GE INPUT VOLTAGE HYSTERESIS MPERATURE	16. 17. 18.	LOW VOLTA SWITCHING VOLTAGE M	THE LOAD	OPROCESSOR RESET OFF WHEN BATTERY REACHES BELOW 2.79 TERY CHARGER
7.	THRESHO SUPPLY CO SUPPLY CO	URRENT V	s. INPUT V					
10. 11. 12.	LOW LEVE LOW LEVE CLAMP DI	EL OUTPU EL OUTPU ODE FOR	T SATURA T SATURA WARD VO	t vs temperature tion voltage vs. temperature tion voltage vs. temperature ltage vs. forward current 5H to Low	ar templom galterá			
				W to HIGH				
				AGE OVER TEMPERATURE				
V	8.9	58.9	22.9	TOE OVER TEITH EIG TORE	VE.2 g2Vii 9 1			
								Total Device



#### 3 V Undervoltage Sensing Circuit

#### PRODUCTION DATA SHEET

FIGURE 1. — INPUT VOLTAGE and RESET OUTPUT VOLTAGE vs. TIME

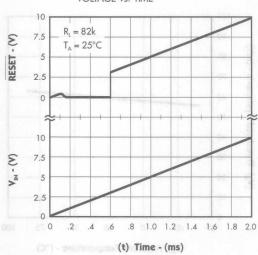


FIGURE 2. — POWER-UP RESET VOLTAGE

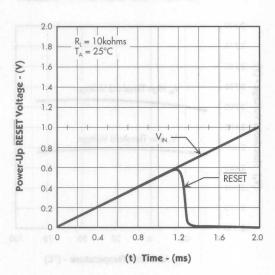


FIGURE 3. — POWER-DOWN RESET VOLTAGE

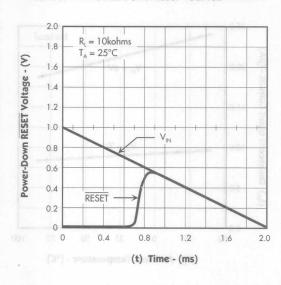
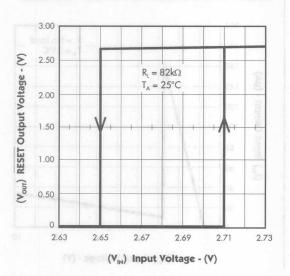


FIGURE 4. — RESET OUTPUT VOLTAGE vs. INPUT VOLTAGE



#### 3 V Undervoltage Sensing Circuit

PRODUCTION DATA SHEET

FIGURE 5. — THRESHOLD VOLTAGE VS. TEMPERATURE

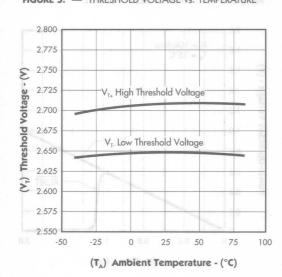


FIGURE 6. — THRESHOLD HYSTERESIS vs. TEMPERATURE

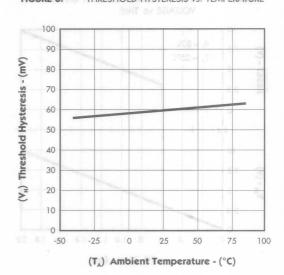


FIGURE 7. — SUPPLY CURRENT vs. INPUT VOLTAGE

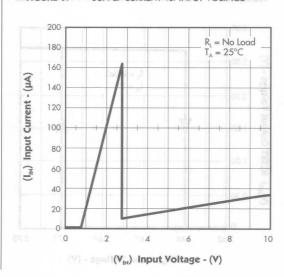
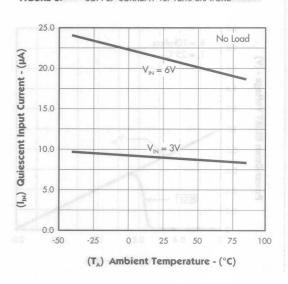


FIGURE 8. — SUPPLY CURRENT vs. TEMPERATURE





# 3 V Undervoltage Sensing Circuit

#### PRODUCTION DATA SHEET

FIGURE 9. — LOW LEVEL OUTPUT CURRENT

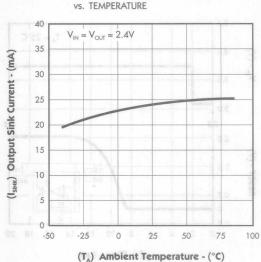


FIGURE 10. — LOW LEVEL OUTPUT SATURATION VOLTAGE vs. TEMPERATURE

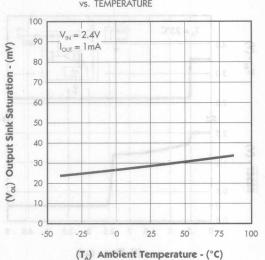
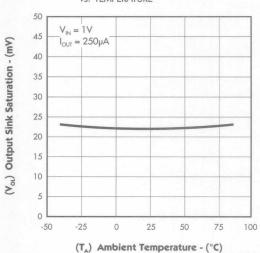
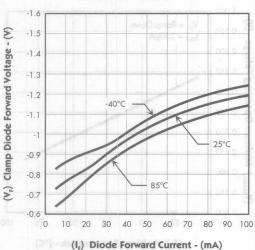


FIGURE 11. — LOW LEVEL OUTPUT SATURATION VOLTAGE FIGURE 12. — CLAMP DIODE FORWARD VOLTAGE vs. TEMPERATURE



vs. FORWARD CURRENT



#### 3 V Undervoltage Sensing Circuit

PRODUCTION DATA SHEET

FIGURE 13. — PROPAGATION DELAY — HIGH to LOW

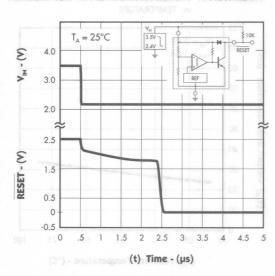


FIGURE 14. — PROPAGATION DELAY — LOW to HIGH

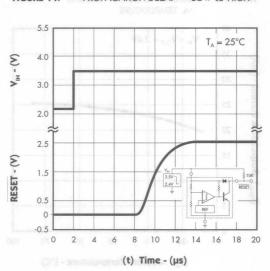
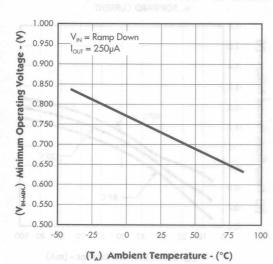
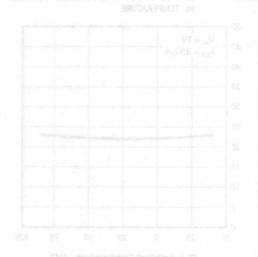


FIGURE 15. — MINIMUM OPERATING VOLTAGE OVER TEMPERATURE





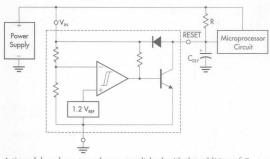


#### 3 V Undervoltage Sensing Circuit

#### PRODUCTION DATA SHEET

#### TYPICAL APPLICATION CIRCUITS

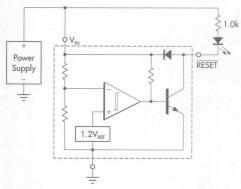
FIGURE 16. — LOW VOLTAGE MICROPROCESSOR RESET



A time delayed reset can be accomplished with the addition of  $C_{\text{DLY}}.$  For systems with extremely fast power supply rise times (< 500ns) it is recommended that the  $RC_{\text{DLY}}$  time constant be greater than 5.0µs.  $V_{\text{TRIMPUD}}$  is the microprocessor reset input threshold.

$$t_{DLY} = R C_{DLY} In \left[ \frac{1}{1 - \frac{V_{TH(MPU)}}{V_{IN}}} \right]$$

FIGURE 18. — VOLTAGE MONITOR



LED turns on when  $V_{IN}$  < 2.7V indicating Power Supply is low.

FIGURE 17. — SWITCHING THE LOAD OFF WHEN BATTERY REACHES BELOW 2.7V

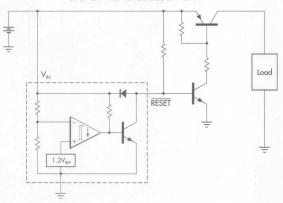
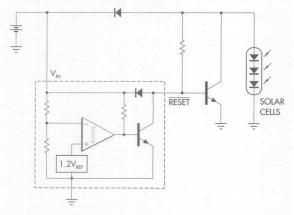


FIGURE 20. — SOLAR POWERED BATTERY CHARGER



# Notes

#### PRODUCTION DATA SHIET

#### HAMRE 42. — SWITCHING THE LOAD OFF-WHEN

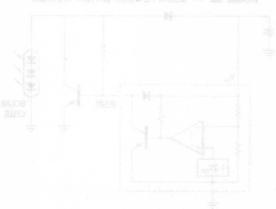


#### WOLFILE 16. -- LOW VOLTAGE MICROPROCESSOR RESELF

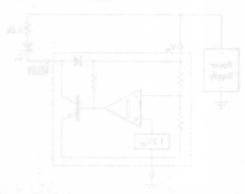


A time delayed reset can be accomplished with the adotton of  $C_{\rm min}$ . For systems with surreme is flux power supply like times  $C \leq 500$ nO it is the accommendent that the  $RC_{\rm min}$  time constant by strategy highest-Outs.  $V_{\rm min}$  is the micromocessor treat inset threshold.

#### REALINE SAL - SOLAR POWERED SATTERY CHARGER



#### FIGHTRE 16. - VOLTAGE MONITOR.



LED turns on when V < 2 "V indicating Power Supply is lost."



SG109/309

#### 5-VOLT FIXED VOLTAGE REGULATORS

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

The SG109/SG309 is a completely self-contained 5V regulator. Designed to provide local regulation at currents up to 1A for digital logic cards, this device is available in the hermetic TO-3, TO-66, TO-39 and hermetic and plastic TO-220 packages.

A major feature of the SG109's design is its built-in protective features which make it essentially blowout proof. These consist of both current limiting to control the peak currents

and thermal shutdown to protect against excessive power dissipation. With the only added component being a possible need for an input bypass capacitor, this regulator becomes extremely easy to apply. Utilizing an improved Bandgap reference design, problems have been eliminated that are normally associated with the zener diode references, such as drift in output voltage and large changes in the line and load regulation.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### KEY FEATURES

- FULLY COMPATIBLE WITH TTL AND DTL
- OUTPUT CURRENT IN EXCESS OF 1A
- INTERNAL THERMAL OVERLOAD PROTECTION
- NO ADDITIONAL EXTERNAL COMPONENTS
- BANDGAP REFERENCE VOLTAGE
- **■** FOLDBACK CURRENT LIMITING

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- MIL M38510 / 10701BXA JAN109T
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

# V<sub>N</sub> 2 CASE IS GROUND K PACKAGE (Top View) V<sub>N</sub> T PACKAGE (Top View) V<sub>N</sub> Q GROUND T PACKAGE (Top View)

PACKAGE ORDER INFORMATION						
T <sub>A</sub> (°C)	K TO-3 Metal Can 3-Terminal	R TO-66 Metal Can 3-Terminal	TO-257 Hermetic 3-pin (Isolated)	T TO-39 Metal Can 3-pin		
0 to 70	SG309K	SG309R	SG309IG	SG309T		
-55 to 125	SG109K	SG109R	SG109IG	SG109T		
MIL-STD-883	SG109K/883B	SG109R/883B	SG109IG/883B	SG109T/883B		
JAN SPEC.	_	_	_	JAN109T		

# Notes

PRODUCTION DATA SHEET

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- 19017/AL AX\$10101 \ G1886M JIM 撤
  - BUILDING DATA AVAILABLE
  - DANSSED IS TRACT TRIBING

capacition, this negulator/becomes extremely care to apply. Undering ne improved Bandarp reference design, problems have been ofinitrated that are normally associated with the zens diode references, such as duit in

none rorerences, seen as that in output vellage and large vitanges in The SG109 SG509 is a completely selfcontained SV regulator. Designed to provide focid regulation at currents up to, JA for digital logic cards, this device is available to the bermedic TO-5. TO-66, TO 59 and hermselfs and plants TO-20 markees.

A major feroure of the SG 109's design is to built-in protective features which make a essentially blowcar proof. These consist of both current limiting to control the neak currents

COMPLETS SPECIEGATIONS ASSELLABLE TROM "LIN" FAX: SYSTEM



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ROADOATT





# **SG117/117A Family**

1.5 AMP THREE TERMINAL ADJUSTABLE VOLTAGE REGULATOR

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

The SG117A Series are 3-terminal positive adjustable voltage regulators which offer improved performance over the original 117 design. A major feature of the SG117A is reference voltage tolerance guaranteed within ± 1%, allowing an overall power supply tolerance to be better than 3% using inexpensive 1% resistors. Line and load regulation performance has been improved as well. Additionally, the SG117A reference voltage is guaranteed not to exceed 2% when operating over the full load, line and power dissipation conditions. The SG117A adjustable regulators offer an improved solution for all positive voltage regulator requirements with load currents up to 1.5A.

**KEY FEATURES** 

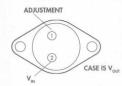
- 1% OUTPUT VOLTAGE TOLERANCE
- 0.01%/V LINE REGULATION
- 0.3% LOAD REGULATION
- MINIMUM 1.5A OUTPUT CURRENT

#### HIGH RELIABILITY FEATURES

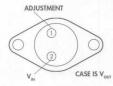
- AVAILABLE TO MIL-STD-883B AND DESC SMD
- MIL-M38510 / 11704BYA JAN117K
- MIL-M38510 / 11703BXA JAN117T
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

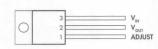
#### PACKAGE PIN OUTS



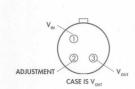
K PACKAGE (Top View)



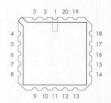
R PACKAGE (Top View)



IG PACKAGE (Top View)



T PACKAGE (Top View)



L PACKAGE (Top View)

1. V <sub>our</sub> SENSE	11. N.C.
2. N.C.	12. N.C.
3. N.C.	13. N.C.
4. N.C.	14. N.C.
5. V <sub>IN</sub>	15. N.C.
6. N.C.	16. N.C.
7. N.C.	17. N.C.
8. N.C.	18. N.C.
9. N.C.	19. N.C.
10. ADJUST	20. V

PACKAGE ORDER INFORMATION						
TO-3 Metal Can 3-Terminal	R TO-66 Metal Can 3-Terminal	TO-257 Hermetic 3-pin (Isolated)	TO-39 Metal Can 3-pin	L Ceramic LCC 20-pin		
SG317AK*	SG317AR*		SG317AT*	_		
SG217AK*	SG217AR*	_	SG217AT*	_		
SG117AK*	SG117AR*	SG117AIG*	SG117AT*	SG117AL*		
SG117AK/883B*	SG117AR/883B*	SG117AIG/883B*	SG117AT/883B*	SG117AL/883B*		
SG117AK/DESC*	SG117AR/DESC*	SG117AIG/DESC*	SG117AT/DESC*	SG117AL/DESC*		
JAN117K	_	_	JAN117T			

<sup>\* &</sup>quot;A" denotes improved performance over the non-"A" version, non-"A" versions also available.

TA (°C)

0 to 70

-25 to 85

-55 to 125

MIL-STD-883

DESC

JAN SPEC.

# Notes



	à.











# SGR117A

RADHARD 1.5A 3-TERMINAL ADJUSTABLE VOLTAGE REGULATOR

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

The RAD HARD SGR117A 3-terminal positive adjustable regulators have been designed to meet the most stringent space and strategic level radiation requirements while meeting the industry standard LM117A and LM117 electrical specifications.

In addition to the features of the standard SGR117A, these devices are capable of meeting the attached data sheet electricals after the following radiation events:

TOTAL DOSE: EXCEEDS 1 MEG RAD

NEUTRON FLUENCE: 5x1012 N/cm2

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### KEY FEATURES

- FULL ELECTRICAL PERFORMANCE AFTER RADIATION EXPOSURE
  - 1 MEG Rad Total Dose 5 x 10<sup>12</sup> N/cm<sup>2</sup>
- 1% OUTPUT VOLTAGE TOLERANCE
- 0.01%/V LINE REGULATION
- 0.3% LOAD REGULATION
- MINIMUM 1.5A OUTPUT CURRENT

#### HIGH RELIABILITY FEATURES

- RADIATION DATA AVAILABLE
- AVAILABLE TO MIL-STD-883B
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

#### PACKAGE PIN OUTS ADJUSTMENT **ADJUSTMENT** CASE IS V CASE IS VOUT K PACKAGE R PACKAGE IG PACKAGE (Top View) (Top View) (Top View) 1 ADJUST CASE IS V<sub>out</sub> T PACKAGE (Top View)

PACKAGE ORDER INFORMATION						
T <sub>A</sub> (°C)	K TO-3 Metal Can 3-Terminal	R TO-66 Metal Can 3-Terminal	IG TO-257 Hermetic 3-pin (Hermetic)	T TO-39 Metal Can 3-pin		
-55 to 125	SGR117AK*	SGR117AR*	SGR117AIG*	SGR117AT*		
MIL-STD-883	SGR117AK/883B*	SGR117AR/883B*	SGR117AIG/883B*	SGR117AT/883B*		

<sup>\* &</sup>quot;A" denotes improved performance over the non-"A" version, non-"A" versions also available.













### NEGATIVE FIXED VOLTAGE REGULATOR

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

The SG120 series of negative regulators offer self-contained, fixed-voltage capability with up to 1.5A of load current. With a variety of output voltages and four package options this regulator series is an optimum complement to the SG7800A/7800/120 line of three terminal regulators.

All protective features of thermal shutdown, current limiting, and safearea control have been designed into these units and since these regulators require only a single output capacitor or a capacitor and 5mA minimum load for satisfactory performance, ease of application is assured.

Although designed as fixed-voltage

regulators, the output voltage can be increased through the use of a simple voltage divider. The low quiescent drain current of the device insures good regulation when this method is used, especially for the SG120 series. Utilizing an improved Bandgap reference design, problems have been eliminated that are normally associated with the zener diode references, such as drift in output voltage and large changes in the line and load regulation

These devices are available in TO-257 (hermetically sealed TO-220), both isolated and non-isolated), TO-3, TO-39 and TO-66 power packages.

### KEY FEATURES

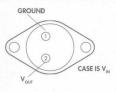
- OUTPUT CURRENT TO 1.5A
- EXCELLENT LINE AND LOAD REGULATION
- FOLDBACK CURRENT LIMITING
- THERMAL OVERLOAD PROTECTION
- VOLTAGES AVAILABLE: -5V, -5.2V, -8V, -12V, -15V, -18V, -20V
- CONTACT FACTORY FOR OTHER VOLTAGE **OPTIONS**

#### HIGH RELIABILITY FEATURES

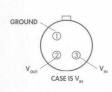
- AVAILABLE TO MIL-STD-883B
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

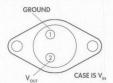
### PACKAGE PIN OUTS



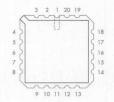
K PACKAGE (Top View)



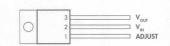
T PACKAGE (Top View)



R PACKAGE (Top View)



L PACKAGE (Top View)



IG PACKAGE (Top View)



PACKAGE ORDER INFORMATION				
TO-3 Metal Can 3-Terminal	R TO-66 Metal Can 3-Terminal	TO-257 Hermetic 3-pin (Isolated)	T TO-39 Metal Can 3-pin	L Ceramic LCC 20-pin
SG120-xxK	SG120-xxR	SG120-xxIG	SG120-xxT	SG120-xxL
SG120-xxK/883B	SG120-xxR/883B	SG120-xxIG/883B	SG120-xxT/883B	SG120-xxL/883B

T, (°C)

-55 to 125

MIL-STD-883

- - # FOLDSACCURRENT LIMITING

- **38 KASIATION DATA AVAILABLE**









			4 17 12 27
	5G120-xodG	36120-xxlk	



## **SG137/137A Family**

### 1.5 AMP NEGATIVE ADJUSTABLE REGULATOR

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

### DESCRIPTION

The SG137A family of negative adjustable regulators will deliver up to 1.5A output current over an output voltage range of -1.2V to -37V. Linfinity has made significant improvements in these regulators compared to previous devices, such as better line and load regulation, and a maximum output voltage error of 1%. The SG137 family uses the same chip design and guarantees maximum output voltage

error of ±2%.

Every effort has been made to make these devices easy to use and difficult to damage. Internal current and power limiting coupled with true thermal limiting prevents device damage due to overloads or shorts even if the regulator is not fastened to a heat sink.

The SG137A/137 family of products are ideal complements to the SG117A/117 adjustable positive regulators.

### KEY FEATURES

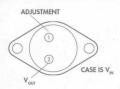
- 1% OUTPUT VOLTAGE TOLERANCE
- 0.01%/V LINE REGULATION
- 0.5% LOAD REGULATION
- 0.02%/W THERMAL REGULATION

### HIGH RELIABILITY FEATURES

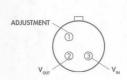
- AVAILABLE TO MIL-STD-883B AND DESC SMD
- SCHEDULED FOR MIL-M38510 QPL TESTING
- MIL-M38510 / 11804BYA JAN137K
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

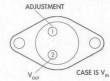
### PACKAGE PIN OUTS



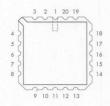
K PACKAGE (Top View)



T PACKAGE (Top View)



R PACKAGE (Top View)



L PACKAGE (Top View)

3	V <sub>out</sub>
2	V
1	ADILIST
	3 2

IG PACKAGE (Top View)

1. V <sub>оит</sub>	11. V <sub>av</sub>
2. Vour	12. N.C.
3. N.C.	13. N.C.
4. N.C.	14. N.C.
5. N.C.	15. N.C.
6. N.C.	16. ADJUST
7. N.C.	17. N.C.
8. N.C.	18. N.C.
9. N.C.	19. N.C.
10. N.C.	20. N.C.

(Top View)		

PACKAGE ORDER INFORMATION					
T <sub>A</sub> (°C)	K TO-3 Metal Can 3-Terminal	R TO-66 Metal Can 3-Terminal	TO-257 Hermetic 3-pin (Isolated)	T TO-39 Metal Can 3-pin	L Ceramic LCC 20-pin
0 to 70	SG337AK*	SG337AR*	_	SG337AT*	_
-25 to 85	SG237AK*	SG237AR*	_	SG237AT*	- 30
-55 to 125	SG137AK*	SG137AR*	SG137AIG*	SG137AT*	SG137AL*
MIL-STD-883	SG137AK/883B*	SG137AR/883B*	SG137AIG/883B*	SG137AT/883B*	SG137AL/883B*
DESC	SG137AK/DESC*	SG137AR/DESC*	SG137AIG/DESC*	SG137AT/DESC*	SG137AL/DESC*
JAN SPEC.	JAN137K	_	_	_	_

<sup>\* &</sup>quot;A" denotes improved performance over the non-"A" version, non-"A" versions also available.









		T <sub>A</sub> .(°C)
	SGOSZARY	





## SG140A/SG140

### POSITIVE FIXED VOLTAGE REGULATOR

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

### DESCRIPTION

The SG140A/140 series of positive regulators offer self contained, fixed-voltage capability with up to 1.5A of load current and input voltage up to 50V (SG140A series only).

These units feature a unique on-chip trimming system to set the output voltages to within ±1.5% of nominal on the SG140A series and ±2.0% on the SG140 series. The SG140A versions also offer much improved line and load regulation characteristics. Utilizing an improved Bandgap reference design, problems have been eliminated that are normally associated with the Zener Diode references, such as drift in output

voltage and large changes in the line and load regulation.

All protective features of thermal shutdown, current limiting, and safearea control have been designed into these units and since these regulators require only a small output capacitor for satisfactory performance, ease of application is assured.

Although designed as fixed-voltage regulators, the output voltage can be increased through the use of a simple voltage divider. The low quiescent drain current of the device insures good regulation when this method is used.

### KEY FEATURES

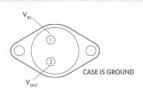
- OUTPUT VOLTAGE SET INTERNALLY TO ±1.5% ON SG140A
- INPUT VOLTAGE RANGE TO 50V MAX. ON SG140A
- 2 VOLT INPUT/OUTPUT DIFFERENTIAL
- BANDGAP REFERENCE VOLTAGE
- EXCELLENT LINE AND LOAD REGULATION
- **■** FOLDBACK CURRENT LIMITING
- THERMAL OVERLOAD PROTECTION
- VOLTAGES AVAILABLE: 5V, 6V, 8V, 12V, 15V, 18V, 24V

### HIGH RELIABILITY FEATURES

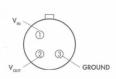
- AVAILABLE TO MIL-STD-883B
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

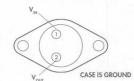
### PACKAGE PIN OUTS



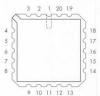
K PACKAGE (Top View)



T PACKAGE (Top View)



R PACKAGE (Top View)



L PACKAGE (Top View)

# 3 V<sub>out</sub> GROUND V<sub>N</sub>

(Top View)

11. N.C.
12. V<sub>OUT</sub>
13. N.C.
14. N.C.
15. V<sub>OUT</sub> SENSE
16. N.C.
17. V<sub>IN</sub>
18. N.C.
19. N.C.

12 13 | 10. V<sub>out</sub> | 20. N.C.

N.C.
 V<sub>IN</sub>

3. N.C. 4. N.C.

5. N.C.

6. N.C.

8. N.C.

9. N.C.

7. GROUND

## PACKAGE ORDER INFORMATION D TO-66 Metal Can Lo TO-257 Hermetic & TO-39 M

T <sub>A</sub> (°C)	K TO-3 Metal Can 3-Terminal	R TO-66 Metal Can 3-Terminal	IG TO-257 Hermetic 3-pin (Isolated)	T TO-39 Metal Can 3-pin	L Ceramic LCC 20-pin
-55 to 125	SG140-xxK	SG140-xxR	SG140-xxAIG*	SG140-xxT	SG140-xxL
MIL-STD-883	3 SG140-xxK/883B	SG140-xxR/883B	SG140-xxAIG/883B*	SG140-xxT/883B	SG140-xxL/883B

"A" denotes improved performance over the non-"A" version, non-"A" versions also available. Note: "xx" to be replaced by output voltage of specific fixed regulator.

OR COLUMN TO WAT YOU TURN TO ME AND THE COLUMN TO ME AND THE COLUMN TO ME AND THE COLUMN TO THE COLU

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the SCHOLA LILL to less of prestroneigniniers offer soft meanined, thickeignine sagest layer alt pp to 1.5% of each deirette and layer of a flager agent NV (SCHOLA LILL of each)

These units to be a conquery with a citating system to set to cathod valuages to work a 1.5m of position of the SQLM set to set to a 2.0m on the significant cathod set to the set to be \$6.0m or set to the analytical cathod citating with the set to the set of the analytical copposed trust and restrict the set of problems have seen eliminated the set of mentily set of the set of the cathod countries.

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LINFINITY
MICROELECTRONICS

## SG1524/2524/3524

### REGULATING PULSE WIDTH MODULATOR

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

### DESCRIPTION

This monolithic integrated circuit contains all the control circuitry for a regulating power supply inverter or switching regulator. Included in a 16-pin dual-in-line package is the voltage reference, error amplifier, oscillator, pulse width modulator, pulse steering flip-flop, dual alternating output switches and current limiting and shutdown circuitry. This device can be used for switching regulators of either

polarity, transformer coupled DC to DC converters, transformerless voltage doublers and polarity converters, as well as other power applications. The SG1524 is specified for operation over the full military ambient temperature range of -55°C to +125°C, the SG2524 for -25°C to +85°C, and the SG3524 is designed for commercial applications of 0°C to +70°C.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

### KEY FEATURES

- 8V TO 40V OPERATION
- **■** 5V REFERENCE
- REFERENCE LINE & LOAD REG. OF 0.4%
- REFERENCE TEMP. COEFFICIENT < ±1%
- 100Hz TO 300KHz OSCILLATOR RANGE
- EXELLENT EXTERNAL SYNC CAPABILITY
- DUAL 50mA OUTPUT TRANSISTORS
- **■** CURRENT LIMIT CIRCUITRY
- COMPLETE PWM POWER CONTROL CIRCUITRY
- SINGLE ENDED OR PUSH-PULL OUTPUTS
- TOTAL SUPPLY CURRENT LESS THAN 10mA

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- MIL-M-38510/12601BEA JAN1524J
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

#### PACKAGE PIN OUTS INV. INPUT INV. INPUT 15 - +VIN N.I. INPUT 15 N.I. INPUT 14 DE OSC. OUTPUT 14 🗆 E<sub>8</sub> OSC. OUTPUT +C.L. SENSE +C.L. SENSE 🖂 4 13 C 13 TC C8 -C.L. SENSE 12 CA -C.L. SENSE I 12 T C 11 | E, 11 EA R, R, I 6 10 SHUTDOWN c. 🗆 10 III SHUTDOWN COMPENSATION GROUND GROUND I 9 COMPENSATION J & N PACKAGE D PACKAGE (Top View) (Top View) 1. N.C. 11. COMPENSATION V<sub>REF</sub> INV. INPUT 12 SHUTDOWN 13. N.C. 4. N.I. INPUT 14. E<sub>A</sub> 17 5. OSC. OUTPUT 15. C<sub>A</sub> 16. N.C. 6. +C.L. SENSE 15 17. C<sub>8</sub> 18. E<sub>8</sub> 19. N.C. 7. -C.L. SENSE 8. R, 9. C, 10. GROUND 20. +V<sub>IN</sub> 9 10 11 12 13 L PACKAGE (Top View)

	PACKAGE ORDER INFORMATION					
T <sub>A</sub> (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	D Plastic SOIC 16-pin	L Ceramic LCC 20-pin		
0 to 70	SG3524N	SG3524J	SG3524D	_		
-25 to 85	SG2524N	SG2524J	SG2524D	_		
-55 to 125	<del>-</del>	SG1524J	-	SG1524L		
MIL-STD-883	<del></del>	SG1524J/883B	-	SG1524L/883B		
DESC		SG1524J/DESC		_		
JAN	_	JAN1524J		_		

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3524DT)

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## SG1524B/2524B/3524B

REGULATING PULSE WIDTH MODULATOR

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

### DESCRIPTION

The SG1524B is a pulse width modulator for switching power supplies which features improved performance over industry standards like the SG1524. A direct pin-for-pin replacement for the earlier device, it combines advanced processing techniques and circuit design to provide improved reference accuracy, and extended common mode range at the error amplifier and current limit inputs. A DC-coupled flip-flop eliminates triggering and glitch prob-

lems, and a PWM data latch prevents edge oscillations. The circuit incorporates true digital shutdown for high speed response, while an undervoltage lockout circuit prevents spurious outputs when the supply voltage is too low for stable operation. Full doublepulse suppression logic insures alternating output pulses when the Shutdown pin is used for pulse-bypulse current limiting.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 3-1) AND 1990/91 SILICON GENERAL DATABOOK

#### KEY FEATURES

- 7V TO 40V OPERATION
- 5V REFERENCE TRIMMED TO ±1%
- 100Hz TO 400KHz OSCILLATOR RANGE
- EXELLENT EXTERNAL SYNC CAPABILITY
- DUAL 100mA OUTPUT TRANSISTORS
- WIDE CURRENT LIMIT COMMON MODE RANGE
- DC-COUPLED TOGGLE FLIP-FLOP
- PWM DATA LATCH
- UNDERVOLTAGE LOCKOUT
- FULL DOUBLE-PULSE SUPPRESION LOGIC
- 60V OUTPUT COLLECTORS

### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

#### PACKAGE PIN OUTS INV INPUT INV. INPUT N.I. INPUT 15 +V N.I. INPUT 15 - +V<sub>IN</sub> 14 🗆 E<sub>8</sub> OSC. OUTPUT OSC. OUTPUT [ 14 □ E<sub>a</sub> +C.L. SENSE 13 C<sub>8</sub> +C.L. SENSE I 13 I C<sub>8</sub> -C.L. SENSE 12 CA -C.L. SENSE I 12 I C R. I 11 DE 11 EA R<sub>T</sub> 10 SHUTDOWN C, 10 SHUTDOWN 9 COMPENSATION GROUND T GROUND I □ COMPENSATION J & N PACKAGE DW PACKAGE (Top View) (Top View) 11. N.C. 1. N.C. 2. INV. INPUT 12. COMPENSATION 3. N.I. INPUT 13. SHUTDOWN 4. OSC. OUTPUT 14. E. 5. +C.L. SENSE 15. C 16 6. N.C. 16. N.C. 15 7. -C.L. SENSE 17. C<sub>8</sub> 8. R<sub>7</sub> 9. C<sub>7</sub> 10. GROUND 18. E<sub>B</sub> 19. +V<sub>IN</sub> 20. V 9 10 11 12 13 L PACKAGE (Top View)

PACKAGE ORDER INFORMATION					
T <sub>A</sub> (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	DW Plastic SOWB 16-pin	L Ceramic LCC 20-pin	
0 to 70	SG3524BN	SG3524BJ	SG3524BDW	_	
-25 to 85	SG2524BN	SG2524JBJ	SG2524BDW	——————————————————————————————————————	
-55 to 125		SG1524BJ	_	SG1524BL	
MIL-STD-883	_	SG1524BJ/883B	-	SG1524BL/883B	
DESC	-	SG1524BJ/DESC	-	<del>-</del>	

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3524BDWT)

MOTAGENO VIENTION

III. 100Hs TO 400HHz OSCILLATOR RANGE

TO DO COUNTED TO GO BE PUR-PLOP



\$G253MBDW		





## SG1525A/SG1527A Family

REGULATING PULSE WIDTH MODULATOR

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

The SG1525A/1527A series of pulse width modulator integrated circuits are designed to offer improved performance and lower external parts count when used to implement all types of switching power supplies. The on-chip +5.1 volt reference is trimmed to ±1% initial accuracy and the input common-mode range of the error amplifier includes the reference voltage, eliminating external potentiometers and divider resistors. A Sync input to the oscillator allows multiple units to be slaved together, or a single unit to be synchronized to an external system clock. A single resistor between the C<sub>r</sub> pin and the Discharge pin provides a wide range of deadtime adjustment. These devices also feature built-in soft-start circuitry with only a timing capacitor required externally. A Shutdown pin controls both the soft-start

circuitry and the output stages, providing instantaneous turn-off with soft-start recycle for slow turn-on. These functions are also controlled by an undervoltage lockout which keeps the outputs off and the soft-start capacitor discharged for input voltages less than that required for normal operation. Another unique feature of these PWM circuits is a latch following the comparator. Once a PWM pulse has been terminated for any reason, the outputs will remain off for the duration of the period. The latch is reset with each clock pulse. The output stages are totem-pole designs capable of sourcing or sinking in excess of 200mA. The SG1525A output stage features NOR logic, giving a LOW output for an OFF state. The SG1527A utilizes OR logic which results in a HIGH output level when OFF.

### KEY FEATURES

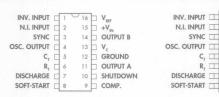
- 8V TO 35V OPERATION
- 5.1V REFERENCE TRIMMED TO ±1%
- 100Hz TO 500KHz OSCILLATOR RANGE
- SEPARATE OSCILLATOR SYNC TERMINAL
- ADJUSTABLE DEADTIME CONTROL
   INTERNAL SOFT-START
- INPUT UNDERVOLTAGE LOCKOUT
- LATCHING PWM TO PREVENT MULTIPLE PULSES
- DUAL SOURCE / SINK OUTPUT DRIVERS

#### HIGH RELIABILITY FEATURES

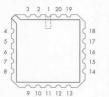
- AVAILABLE TO MIL-STD-883B
- MIL-M-38510 / 12602BEA JAN1525AJ
- MIL-M-38510 / 12604BEA JAN1527AJ
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

### PACKAGE PIN OUTS







N.C.
 INV. INPUT
 N.I. INPUT
 SYNC
 OSC. OUTPUT
 N.C.
 C,
 R,
 DISCHARGE
 10. SOFT-START

11. N.C.
12. COMP.
13. SHUTDOWN
14. OUTPUT A
15. GROUND
16. N.C.
17. V<sub>C</sub>
18. OUTPUT B

19. +V<sub>IN</sub>

20. V,,,

J & N PACKAGE (Top View) **DW PACKAGE** (Top View)

L PACKAGE (Top View)

PACKAGE ORDER INFORMATION						
T <sub>A</sub> (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	DW Plastic SOWB 16-pin	L Ceramic LCC 20-pin		
0 to 70	SG3525AN	SG3525AJ	SG3525DW	_		
	SG3527AN	SG3525AJ	SG3525DW	-		
-25 to 85	SG2525AN	SG2525AJ	SG2525ADW	_		
	SG2527AN	SG2527AJ	SG2527ADW	_		
-55 to 125	_	SG1525AJ	_	SG1525AL		
	_	SG1527AJ	_	SG1527AL		
MIL-STD-883	_	SG1525AJ/883B	_	SG1525AL/883B		
	_	SG1527AJ/883B	_	SG1527AL/883B		
DESC	_	SG1525AJ/DESC	_	_		
	_	SG1527AJ/DESC	_	_		
JAN	_	JAN1525A				
	_	JAN1527A	_	-		

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3525DWT)

ROBUCTION BATA SHILT

#### 10 74 49 3 2 3 2

SV TO 35V OPERATION

S 1V SERVENCE TRIMMED TO 41%

TOORS TO SOUTH OSCILLATOR RANGE

SEPARATE OSCILLATOR SINIC TERMINA
 ADJUSTABLE DEADTIME CONTROL

DEVIS-LICS TANGERNI FR

# LATCHING PAWN TO PREVENT MELTIFILE PULSES

# DUAL SOURCE / SINK GLIPPUT DRIVERS

ng instantineous turneoff with soft-setted veryele for slow num- of. These functions are also controlled by an uniforvoltage lockern which iceps the outputs off middle of signal veryeles less than that required or input veryinges less than that required or input veryinges less than that required output of these PWM circuits is a latch calling of these PWM circuits is a latch whise has been terminated for any readily that the curputs will reintain off for the car, the curputs will reintain off for the me totem-poit designs capable of sourcing or sulting it overess of 206mA. The new totem-poit designs capable of sources of 206mA. The oping a LOW carpan for an OFF total and the sulting a LOW carpan for an OFF total capable, results on a HIGH output level which results on a HIGH output level

The SG1525A/1527A series of pulse width modulator integrated circulas are designed to offer improved performance and lower external parts count when used to implement all opes of wirething powers supplies. The on-chip 45.1 will reference is manned to ath initial necessary and the input common-used range of the error amplifier includes the crier of the error amplifier includes the crier rentiometers and divider resistors. A sentiometer and divider resistors. A Sync input to the oscillator allows multiple units to be synchronized to an tiple units to be synchronized to an ships crierion provides a wide range of deadting pin provides a wide range of deadting pin provides. It wide range of deadting builtim solt-start circuites with only a builtim solt-start circuites with only a builtim solt-start circuites with the soli-start finning capacitor required externally. A

#### SOUTABLE VIOLENCE REAT REATER

OR AVAILABLE TO MIL-STD-BUSH

■ NIL-M-38510 / 196046EA - JAN1527AJE

I UNRINITY LEVEL "S" PROCESSING AVAIL

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SUCON GENERAL DATABOOK

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All surface-mount packages are couldsbe in Tape & Reel. Append the letter IT to pair number. (i.e. SGSSSBWT)





## SG1526/SG2526/SG3526

REGULATING PULSE WIDTH MODULATOR

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

The SG1526 is a high performance monolithic pulse width modulator circuit designed for fixed-frequency switching regulators and other power control applications. Included in an 18-pin dual-in-line package are a temperature compensated voltage reference, sawtooth oscillator, error amplifier, pulse width modulator, pulse metering and steering logic, and two low impedance power drivers. Also included are protective features such as soft-start and undervoltage lockout,

digital current limiting, double pulse inhibit, a data latch for single pulse metering, adjustable deadtime, and provision for symmetry correction inputs. For ease of interface, all digital control ports are TTL and B-series CMOS compatible. Active LOW logic design allows wired-OR connections for maximum flexibility. This versatile device can be used to implement singleended or push-pull switching regulators of either polarity, both transformerless and transformer coupled.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

### KEY FEATURES

- 8V TO 35V OPERATION
- 5V REFERENCE TRIMMED TO ±1%
- 1Hz TO 350KHz OSCILLATOR RANGE
- DUAL 100mA SOURCE/SINK OUTPUTS
- DIGITAL CURRENT LIMITING
- DOUBLE PULSE SUPPRESSION
- PROGRAMMABLE DEADTIME
- UNDERVOLTAGE LOCKOUT
- SINGLE PULSE METERING
- PROGRAMMABLE SOFT-START
- WIDE CURRENT LIMIT COMMON MODE RANGE
- TTL/CMOS COMPATIBLE LOGIC PORTS
- SYMMETRY CORRECTION CAPABILITY
- GUARANTEED 6 UNIT SYNCHRONIZATION

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.



PACKAGE ORDER INFORMATION						
T <sub>A</sub> (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	DW Plastic SOWB 16-pin	L Ceramic LCC 20-pin		
0 to 70	SG3526N	SG3526J	SG3526DW	_		
-25 to 85	SG2526N	SG2526J	SG2526DW	_		
-55 to 125	-	SG1526J	_	SG1526L		
MIL-STD-883	1-	SG1526J/883B	_	SG1526L/883B		

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3526DWT)

PODECTION DATA SHEET

CHE INFINITE POWER OF INSCRICM

The SG1526 is a high performance monolithic pulse width modulator circuit designed for fixed-brquency circuit designed for fixed-brquency switching regulators and other power control applications. Included in an 18-pin dual-in-line package are a temperature comprehence witage reference, say tooth oscillator, enter amplifier, pulse width modulator, pulse metering and streting logic, and two low impedance power drivers. Also low impedance power drivers. Also and accounter and its analysis of the same such as an accounter and its analysis of the same such as an accounter and its analysis of the same such as a same and a same and a same such as a same and a same a sa

digital current limiting, double pulse inhibit, a data latch for single pulse motering, adjustable desdrime, and provision for sympatry execution provision for symmetry execution inquis. For case of interface, all digital inquis. For case of interface, all digital compatible. Active LOW logic design allows wined-OR connections for maximum flexibility. This versaille device can be used to implement single ended or push pull switching regulators of either potarity, both functionedless and transformer coupled.

COMPLETE SPECIFICATIONS AVAILABLE PRODUCTION "LIN" FAX SYSTEM

M AVAILABLE TO MIL-STD-B238
M RADIATION DATA AVAILABLE



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one. All surface-mount practicages are available in Pape & Roel. Append the letter T to part number. (i.e. SC3520DWT)



## SG1526B/SG2526B/SG3526B

REGULATING PULSE WIDTH MODULATOR

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

### DESCRIPTION

The SG1526B is a high-performance pulse width modulator for switching power supplies which offers improved functional and electrical characteristics over the industry-standard SG1526. A direct pin-for-pin replacement for the earlier device with all its features, it incorporates the following enhancements: a bandgap reference circuit for improved regulation and drift characteristics, improved undervoltage lockout, lower temperature coefficients on oscillator

frequency and current-sense threshold, tighter tolerance on softstart time, much faster SHUTDOWN response, improved double-pulse suppression logic for higher speed operation, and an improved output driver design with low shoot-through current, and faster rise and fall times. This versatile device can be used to implement single-ended or push-pull switching regulators of either polarity, both transformer-less and transformer-coupled.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

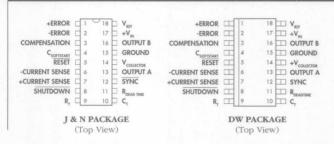
#### KEY FEATURES

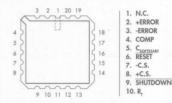
- 8V TO 35V OPERATION
- 5V LOW DRIFT 1% BANDGAP REFERENCE
- 1Hz TO 500KHz OSCILLATOR RANGE
- DUAL 100mA SOURCE/SINK
- DIGITAL CURRENT LIMITING
- DOUBLE PULSE SUPPRESSION
- PROGRAMMABLE DEADTIME
- IMPROVED UNDERVOLTAGE LOCKOUT
- SINGLE PULSE METERING
- PROGRAMMABLE SOFT-START
- WIDE CURRENT LIMIT COMMON MODE RANGE
- TTL/CMOS COMPATIBLE LOGIC PORTS
- SYMMETRY CORRECTION CAPABILITY
- GUARANTEED 6 UNIT SYNCHRONIZATION
- SHOOT THRU CURRENTS LESS THAN
- IMPROVED SHUTDOWN DELAY
- IMPROVED RISE AND FALL TIME

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- MIL-M38510/12603BVA JAN1526BJ
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

### PACKAGE PIN OUTS







L PACKAGE (Top View)

PACKAGE ORDER INFORMATION						
T <sub>A</sub> (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	DW Plastic SOWB 16-pin	L Ceramic LCC 20-pin		
0 to 70	SG3526BN	SG3526BJ	SG3526BDW	_		
-25 to 85	SG2526BN	SG2526BJ	SG2526BDW	_		
-55 to 125	_	SG1526BJ	_	SG1526BL		
MIL-STD-883	_	SG1526BJ/883B	_	SG1526BL/883B		
DESC	_	SG1526BJ/DESC	_	_		
JAN	_	JAN1526BJ		_		

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3526BDWT)

The SGISSOR is a high-performance pulse width mechanise for switching power supplies which offers improved functional and electrical characteristics over the and isty-standard SGISSO. A direct placfor-plan replacement for the cutter device with all is features, it incorporates the following enhancements is candigup reference circuit for improved regulation and dolft characteristics, improved anderwoltage locional, lower

frequency and current sense hireshold, aginer telerance on softwart time, much fingler telerance sin softwart time, much double-pulse suppression logic for higher speed operation, and an improved outnor driver design with low shoot-drough current, and faster rise and full times. This versatile clevice can be used to implement single-ended or push-pull switching regularies of either polarity, both transformer-less and prolarity both transformer-less and transformer-countled.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM

#### SEPTEMBER OF STREET

- MOTATE STATION
- B SVEOW DRIP I'V BYROEVE RELEGING
- # DUAL 100mA SOURCE/SINK
  - CHARLEST TO STATE OF THE STATE OF
  - III DIGITAL CAREAT LIMITING
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  - JANEGACIO SIBARANA OGOCAN W
    - THE CHARGE OF REAL PROPERTY.
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- STROP DESCRIPTIBLE LOCAL PORTS
- WINNESS COMPLESS CONVENDED
- PHACH THIS CURRING LESS THAN TOOMS
  - S INPROVED SPUTDOWN DELAY
  - IMPROVED RISE AND FALL TIME

#### HIGH RELIABILITY SEATURE

- M AVAILABLETO MILISTD-BRIB
- BIORGLAVI VASEROXUDI SESWI-TIM #
- B. BABARTON DATA AVAILABLE
- I HAMMAN LEVEL 'S' PROCESSING ANALL

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icie. All surface-moute packinges are available in Tape & Berd. Appendithe lengt "T" to put stanker. G c. 50 552/BDWT3



## SG1529/2529/3529

### REGULATING PULSE WIDTH MODULATOR

THE INFINITE POWER OF INNOVATION

NOT RECOMMENDED FOR NEW DESIGNS

### DESCRIPTION

The SG1529 series of pulse width modulator integrated circuits are designed to provide all the operational features of the SG1524B series with the added advantage of an uncommitted input to the PWM comparator. This allows the device to be used in Feed-Forward regulation schemes to achieve better line regulation as well as improved dynamic response. A 5V bandgap reference trimmed to ±1% tolerance, an error amplifier, and a current limit comparator with a high common mode range are included in the IC.

A DC coupled flip-flop eliminates triggering and glitch problems, and a PWM data latch prevents edge oscillations. The circuit incorporates true digital shutdown for high speed response while an undervoltage lockout circuit prevents spurious outputs when the supply voltage is too low for stable operation. Full double-pulse suppression logic insures alternating output pulses when the Shutdown pin is used for pulse-by-pulse current limiting.

### KEY FEATURES

- FEED FORWARD CAPABILITY
- 7V TO 40V OPERATION
- 5V REFERENCE TRIMMED TO ±1%
- 100Hz TO 400KHz OSCILLATOR RANGE
- EXELLENT EXTERNAL SYNC CAPABILITY
- DUAL 100mA OUTPUT TRANSISTORS
- WIDE CURRENT LIMIT COMMON MODE RANGE
- DC-COUPLED TOGGLE FLIP-FLOP
- PWM DATA LATCH
- UNDERVOLTAGE LOCKOUT
- FULL DOUBLE-PULSE SUPPRESION LOGIC
- 60V OUTPUT COLLECTORS

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### PACKAGE PIN OUTS

INV. INPUT	d	1	18	Ъ	N.C.
N.I. INPUT	d	2	17	6	Vper
OSC. OUTPUT		3	16	b	+V <sub>IN</sub>
+C.L. SENSE		4	15	Ь	E,
-C.L. SENSE		5	14	b	C <sub>R</sub>
R <sub>r</sub>		6	13		C
C <sub>r</sub>		7	12	Þ	E,
F.F.		8	11	Þ	SHUTDOWN
GROUND		9	10	Þ	COMPENSATION
		П			

J & N PACKAGE (Top View)

### PACKAGE ORDER INFORMATION

T <sub>A</sub> (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin
0 to 70	SG3529N	SG3529J
-25 to 85	SG2529N	SG2529J
-55 to 125	_	SG1529J
MIL-STD-883	_	SG1529J/883B

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## SG1532/SG2532/SG3532

### PRECISION GENERAL-PURPOSE REGULATOR

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

This monolithic integrated circuit is a versatile, general-purpose voltage regulator designed as a substantially improved replacement for the popular SG723 device. The SG1532 series regulators retain all the versatility of the SG723 but have the added benefits of operation with input voltages as low as 4.5 volts and as high as 50 volts; a low noise, low voltage reference; temperature compensated, low threshold current limiting; and protective circuits which include thermal shutdown and independent

current limiting; and protective circuits which include thermal shutdown and independent current limiting of both the reference and output voltages. A seperate remote shutdown terminal is included. In the dual-in-line package an open collector output is available for low input-output differential applications.

These devices are available in both hermetic 14-pin and 10-pin TO-96 packages. In the T-package, these units are interchangeable with the LAS-1000 and LAX-1100 regulators.

#### KEY FEATURES

- INPUT VOLTAGE RANGE OF 4.5V TO 50V
- 2.5V LOW NOISE REFERENCE
- INDEPENDENT SHUTDOWN TERMINAL
- IMPROVED LINE AND LOAD REGULATION
- 80mV CURRENT LIMIT SENSE VOLTAGE
- FULLY PROTECTED INCLUDING THERMAL SHUTDOWN
- USEFUL OUTPUT CURRENT TO 150mA

#### HIGH RELIABILITY FEATURES

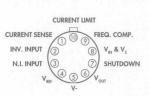
- AVAILABLE TO MIL-STD-883B
- LINFINITY LEVEL "S" PROCESSING **AVAILABLE**

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

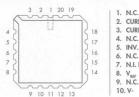
### PACKAGE PIN OUTS



**J PACKAGE** (Top View)



T PACKAGE (Top View)



2. CURRENT LIMIT 3. CURRENT SENSE 4. N.C. 5. INV. INPUT 6. N.C. 7. N.I. INPUT

14. N.C. 15. V<sub>out</sub> 16. N.C. 17. V<sub>c</sub> 18. V<sub>IN</sub> 19. N.C. 20. FREQ. COMP.

12. SHUTDOWN

I. PACKAGE (Top View)

PACKAGE ORDER INFORMATION					
T <sub>A</sub> (°C)	J Ceramic DIP 14-pin				
0 to 70	SG2532J	SG2532T			
	SG3532J	SG3532T			
-55 to 125	SG1532J	SG1532T	SG1532L		
MIL-STD-883	SG1532J/883B	SG1532T/883B	SG1532L/883B		
DESC	SG1532J/DESC	SG1532T/DESC	_		

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## SG1540/SG2540/SG3540

OFF-LINE START-UP CONTROLLER

THE INFINITE POWER OF INNOVATION

NOT RECOMMENDED FOR NEW DESIGNS / LIFETIME BUY

### DESCRIPTION

The SG1540 is an integrated circuit designed to efficiently provide start-up power from a high-voltage DC bus to a PWM control circuit in a switching power supply. When used on the primary side, it reduces start-up current to less than 1mA and allows any standard PWM control circuit to be used as a primary-side controller. When used to power a controller on the secondary side, it efficiently eliminates the need for a heavy 50/60Hz line transformer with its associated low frequency magnetic fields.

The circuit consists of three sections: a micropower bandgap comparator/

power switch referenced to 2.5 volts which isolates the start-up capacitor from its load; a high frequency square-wave oscillator with 200mA totem-pole output for driving an isolation transformer; and a second bandgap comparator with latching crowbar to protect against overvoltage faults while starting or running.

The SG1540 is specified for operation over the full military ambient temperature range of -55°C to 125°C. The SG2540 is characterized for the industrial range of -25°C to 85°C, and the SG3540 is designed for the commercial range of 0°C to 70°C.

### KEY FEATURES

- USEABLE WITH PRIMARY AND SECONDARY SIDE PWM CONTROLLERS
- MICROPOWER COMPARATOR / SWITCH
  - INTERNAL 2.5V BANDGAP REFERENCE
  - 50mA POWER SWITCH
- SQUAREWAVE OSCILLATOR
  - 500Hz TO 200KHz OPERATION
  - 200mA TOTEM POLE OUTPUTS
- ELIMINATES BULKY, EXPENSIVE 50/60 Hz TRANSFORMER
- INPUT CURRENT 35nA MAXIMUM OVER TEMPERATURE
- MINIMIZES HIGH VOLTAGE BLEEDER CURRENT
- PROGRAMMABLE START-UP VOLTAGE AND HYSTERESIS
- INTERNAL AND PROGRAMMABLE OVERVOLTAGE CROWBAR LATCH

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### PACKAGE PIN OUTS START 8 DC OUT OVER VOLTAGE 2 7 - +V<sub>IN</sub> HYSTERESIS AC OUT TIMING GROUND M & Y PACKAGE (Top View) START T 16 I DC OUT N.C. 15 I N.C. OVER VOLTAGE 14 - +V<sub>IN</sub> 13 III N.C. N.C. HYSTERESIS [ N.C. 11 I N.C. TIMING I ☐ GROUND N.C. □ N.C. DW PACKAGE (Top View)

PACKAGE ORDER INFORMATION					
T <sub>A</sub> (°C)	M Plastic DIP 8-pin	Y Ceramic DIP 8-pin	DW Plastic SOWB 16-pin		
0 to 70	SG3540M	SG3540Y	SG3540DW		
-25 to 85	SG2540M	SG2540Y	SG2540DW		
-55 to 125	_	SG1540Y	_		
MIL-STD-883		SG1540Y/883B	_		

Note: All surface-mount packages are available in Tape & Reel.

Append the letter "T" to part number. (i.e. SG3540DWT)

### FOR FURTHER INFORMATION CALL (714) 898-8121

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- III USEABLE WITH PRIMARY AND:
- M WIGROPOWER COMPARATOR / SWITCH \* INTERIOR 2.5V BANDGAP RETRENCE
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  - # 500H2 TO 900H2 OPERATION
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    OVERVOLTAGE CLOWBAR LATCH

power switch referenced to 2.5 voluwhich isolates the start-up expected from its load: a high frequency squarewave oscillator with 200m3 outer-pole output that driving in isolation unitsformer, and a second bandgup compender with lawbarg crewing to protect against over ollage faults while saving

The 56 I540 is specified for operation over the full military ambient requesttions range at 55% or 125%. The 861250 is characterized for me inclinated until range of 25% to 85%, and the S65540 is designed for the commercial range of 6% to 70%. The SC1540 is an integrated careful designed to efficiently provide stancing power from a high-voltage DC bus to a power from a high-voltage DC bus to a power supply. When used on the primary side, it reduces star-up current to less than 1 cp.A and allows any used as a pamary-side controller. When used to power a controller the secondary side, it efficiently the secondary side, it efficiently 60Hz lines the need for a heavy 50/60Hz lines that some side with its associated low frequency magnetic fields.

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Complete specifications available filidm "UN" Fax System (See Page 4-1) and 1990/91 Selcon General Databook

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## SG1543/SG2543/SG3543

POWER SUPPLY OUTPUT SUPERVISORY CIRCUIT

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

This monolithic integrated circuit contains all the functions necessary to monitor and control the output of a sophisticated power supply system. Over-voltage (O.V.) sensing with provision to trigger an external SCR "crowbar" shutdown; an under-voltage (U.V.) circuit which can be used to monitor either the output or to sample the input line voltage; and a third op amp/comparator usable for current sensing (C.L.) are all included in this IC, together with an independent, accurate reference generator.

Both over and under-voltage sensing circuits can be externally programmed for minimum time duration of fault before triggering. All functions contain open collector outputs which can be used independently or wire-ORed together; and although the SCR trigger is directly connected only to the over-

voltage sensing circuit, it may be optionally activated by any of the other outputs, or from an external signal. The O.V. circuit also includes an optional latch and external reset canability.

The current sense circuit may be used with external compensation as a linear amplifier or as a high gain comparator. Although nominally set for zero input offset, a fixed threshold may be added with an external resistor. Instead of current limiting, this circuit may also be used as an additional voltage monitor.

The reference generator circuit is internally trimmed to eliminate the need for external potentiometers and the entire circuit may be powered directly from either the output being monitored or from a seperate bias voltage.

#### **KEY FEATURES**

- OVER-VOLTAGE, UNDER-VOLTAGE, AND CURRENT SENSING CIRCUITS ALL INCLUDED
- REFERENCE VOLTAGE TRIMMED TO 1% ACCURACY
- SCR "CROWBAR" DRIVE OF 300mA
- PROGRAMMABLE TIME DELAYS
- OPEN-COLLECTOR OUTPUTS AND REMOTE ACTIVATION CAPABILITY
- TOTAL STANDBY CURRENT LESS THAN 10mA

#### HIGH RELIABILITY FEATURES

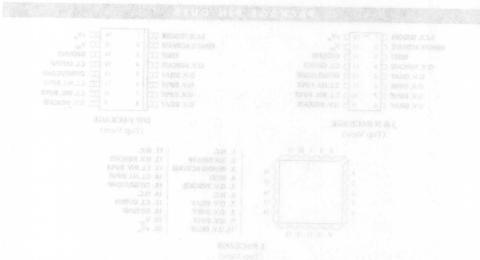
- AVAILABLE TO MIL-STD-883B
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### PACKAGE PIN OUTS S.C.R. TRIGGER S.C.R. TRIGGER REMOTE ACTIVATE | 2 15 VREF 15 V<sub>REF</sub> 14 GROUND REMOTE ACTIVATE RESET 14 GROUND RESET \_\_\_ C.L. OUTPUT O.V. INDICATE 13 O.V. INDICATE 13 C.L. OUTPUT O.V. DELAY OFFSET/COMP 12 12 \_\_\_ OFFSET/COMP O.V. DELAY I C.L. N.I. INPUT O.V. INPUT O.V. INPUT 11 C.L. N.I. INPUT U.V. INPUT 10 C.L. INV. INPUT C.L. INV. INPUT U.V. INPUT 10 U.V. DELAY U.V. INDICATE U.V. DELAY \_\_\_ 9 U.V. INDICATE J & N PACKAGE DW PACKAGE (Top View) (Top View) 1. N.C. 11. N.C. 2. SCR TRIGGER 12. U.V. INDICATE REMOTE ACTIVATE 13. C.L. INV. INPUT 14. C.L. N.I. INPUT 4. RESET 17 5. O.V. INDICATE 15. OFFSET/COMP 16 6. N.C. 16. N.C. 17. C.L. OUTPUT 7. O.V. DELAY 8. O.V. INPUT 18. GROUND 19. V<sub>REF</sub> 20. +V<sub>IN</sub> 9. U.V. INPUT 10. U.V. DELAY 9 10 11 12 13 L PACKAGE (Top View)

PACKAGE ORDER INFORMATION				
T <sub>A</sub> (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	DW Plastic SOWB 16-pin	L Ceramic LCC 20-pin
0 to 70	SG3543N	SG3543J	SG3543DW	_
-25 to 85	SG2543N	SG2543J	SG2543DW	_
-55 to 125	_	SG1543J	_	SG1543L
MIL-STD-883	_	SG1543J/883B	_	SG1543L/883B
DESC	_	SG1543J/DESC	<u> </u>	_

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3543DWT)



Cenamic LCC 20-pin		
	SG15433/8833	





## SG1544/SG2544/SG3544

LOW-VOLTAGE SUPERVISORY CIRCUIT

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

### DESCRIPTION

This device was designed to provide all the operational features of the SG1543/ 2543/3543 devices but with the added advantage of uncommitted inputs to the voltage sensing comparators. This allows monitoring of voltage levels less than 2.5 volts by dividing down the internal reference supply.

In all other respects, the SG1544 series is identical to the SG1543 series. These monolithic devices contain all the functions necessary to monitor and control the output of a sophisticated power supply system. Over-voltage sensing with provision to trigger an external SCR "crowbar" shutdown; an under-voltage circuit which can be used to monitor either the output or sample

the input line voltage; and a third op amp/comparator usable for current sensing are all included in this IC, together with an independent, accurate reference generator.

The voltage-sensing input comparators are identical and can be used with threshold levels from zero volts to (V<sub>IN</sub>-3V). Each has approximately 25mV of hysteresis which is offset so the switching differential threshold is zero on the non-inverting input for rising levels and zero on the inverting input for falling signals. All other operating characteristics are as described in the SG1543 data sheet and application

#### **KEY FEATURES**

- UNCOMMITTED COMPARATOR INPUTS FOR WIDE INPUT FLEXIBILITY
- COMMON-MODE RANGE FROM ZERO TO NEAR SUPPLY VOLTAGE
- REFERENCE VOLTAGE TRIMMED TO 1% **ACCURACY**
- OVER-VOLTAGE, UNDER-VOLTAGE, AND CURRENT SENSING CIRCUITS ALL INCLUDED
- SCR "CROWBAR" DRIVE OF 300mA
- PROGRAMMABLE TIME DELAYS
- OPEN-COLLECTOR OUTPUTS AND REMOTE **ACTIVATION CAPABILITY**
- TOTAL STANDBY CURRENT LESS THAN

### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### PACKAGE PIN OUTS S.C.R. TRIGGER S.C.R. TRIGGER 18 T +VIN REMOTE ACTIVATE 2 REMOTE ACTIVATE 17 VREF 17 V VREF RESET \_\_\_ RESET 16 GROUND 16 GROUND O.V. INDICATE O.V. INDICATE 15 C.L. OUTPUT 15 C.L. OUTPUT O.V. DELAY OFFSET/COMP O.V. DELAY 14 OFFSET/COMP 14 O.V. N.I. INPUT 13 C.L. N.I. INPUT O.V. N.I. INPUT 13 C.L. N.I. INPUT U.V. INV. INPUT C.L. INV. INPUT 12 C.L. INV. INPUT 12 O.V. INV. INPUT U.V. N.I. DELAY U.V. INDICATE 11 U.V. INDICATE U.V. N.I. INPUT U.V. INV. INPUT 10 U.V. DELAY 10 U.V. DELAY U.V. INV. INPUT J & N PACKAGE **DW PACKAGE** (Top View) (Top View)

PACKAGE ORDER INFORMATION				
T <sub>A</sub> (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	DW Plastic SOWB 16-pin	
0 to 70	SG3544N	SG3544J	SG3544DW	
-25 to 85	SG2544N	SG2544J	SG2544DW	
-55 to 125	<del>-</del>	SG1544J		
MIL-STD-883	(*************************************	SG1544J/883B	_	
DESC	_	SG1544J/DESC	_	

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3544DWT)

FOR FURTHER INFORMATION CALL (714) 898-8121

PRODUCTION DATA SHEET

**B** COMMON-MODE RANGE FROM ZERO TO





THE INFINITE POWER OF INNOVATION

## SG1548/SG2548/SG3548

QUAD POWER FAULT MONITOR

PRODUCTION DATA SHEET

### DESCRIPTION

The SG1548 is an integrated circuit capable of monitoring up to four positive DC supply voltages simultaneously for overvoltage and undervoltage fault conditions. An onchip inverting op amp also allows monitoring one negative DC voltage. The fault tolerance window is accurately programmable from ±5% to ±40% using a simple divider network on the 2.5V reference. A single external capacitor sets the fault indication delay, eliminating false outputs due to switching noise, logic transition current spikes, and shortterm AC line interruptions.

An additional comparator referenced to 2.5V allows the AC line to be monitored for undervoltage conditions or for generation of a line clock. The comparator can also be used for programmable undervoltage lockout in a switching power supply.

Uncommitted collector and emitter outputs permit both inverting and non-inverting operation. External availability of the precision 2.5V reference and open-collector logic outputs permit expansion to monitor additional voltage using available open-collector quad comparators.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### KEY FEATURES

- MONITORS 4 DC VOLTAGES & THE AC LINE
- PRECISION 2.5V ±1% LOW-DRIFT REFERENCE
- FAULT TOLERANCE ADJUSTABLE FROM ±5% TO ±40%
- ±3% TRIP THRESHOLD TOL. OVER TEMP.
- SEPERATE 10mA, 40V OVERVOLTAGE, UNDERVOLTAGE & AC LINE FAULT OUTPUTS
- FAULT DELAY PROGRAMMABLE WITH SINGLE CAPACITOR
- 30mV COMPARATOR HYSTERESIS TO PREVENT OSCILLATIONS
- ON-CHIP INVERTING OP AMP FOR NEGATIVE VOLTAGE
- OPEN-COLLECTOR OUTPUT LOGIC OR EXPANDABILITY
- OPERATION FROM 4.5V TO 40V SUPPLY

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- LINFINITY LEVEL "S" PROCESSING AVAIL

#### PACKAGE PIN OUTS LOWER THRESHOLD INV. OUTPUT LOWER THRESHOLD \_\_\_ INV. OUTPUT 15 INV. INPUT GROUND \_\_\_ INV. INPUT GROUND 15 SENSE 4 14 SENSE 4 V<sub>REF</sub> 14 $V_{\text{REF}}$ 13 SENSE 3 SENSE 3 +V<sub>IN</sub> +V<sub>IN</sub> I 13 LINE SENSE 12 SENSE 2 LINE SENSE \_\_\_ 12 SENSE 2 SENSE 1 U.V. FAULT **EMITTER OUTPUT** 11 SENSE 1 EMITTER OUTPUT COLLECTOR OUTPUT U.V. FAULT COLLECTOR OUTPUT 10 O.V. FAULT DFLAY 9 O.V. FAULT DELAY | J & N PACKAGE DW PACKAGE (Top View) (Top View) 1. N.C. 11. N.C. 2. LOWER THRESHOLD 12. O.V. FAULT 3. GROUND 13. U.V. FAULT 18 4. V<sub>REF</sub> 5. +V<sub>IN</sub> 6. N.C. 14. SENSE 1 17 15. SENSE 2 16 16. N.C. 15 7. LINE SENSE 17. SENSE 3 8 EMITTER OUTPUT 18 SENSE A 9. COLLECTOR OUTPUT 19 INV INPUT 10. DELAY 20. INV. OUTPUT 9 10 11 12 13 L PACKAGE (Top View)

PACKAGE ORDER INFORMATION				
T <sub>A</sub> (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	DW Plastic SOWB 16-pin	L Ceramic LCC 20-pin
0 to 70	SG3548N	SG3548J	SG3548DW	
-25 to 85	SG2548N	SG2548J	SG2548DW	_
-55 to 125	_	SG1548J	_	SG1548L
MIL-STD-883		SG1548J/883B	_	SG1548L/883B

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3548DWT)







## SG1549/SG2549/SG3549

CURRENT SENSE LATCH

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

This monolithic integrated circuit is an analog latch device with digital reset. It was specifically designed to provide pulse-by-pulse current limiting for switch-mode power supply systems, but many other applications are also feasible. Its function is to provide a latching switch action upon sensing an input threshold voltage, with reset accomplished by an external clock signal. This device can be interfaced directly with many kinds of pulse width modulating control IC's, including the SG1524, SG1525A, and SG1527A.

The input threshold for the latch circuit is 100mV, which can be referenced either to ground or to a wide-ranging positive voltage. There are high and low-going output signals available, and both the supply voltage and clock signal can be taken directly from an associated PWM control chip.

With delays in the range of 200 nanoseconds, this latch circuit is ideal for fast reaction sensing to provide overall current limiting, short circuit protection, or transformer saturation control.

#### KEY FEATURES

- CURRENT SENSING WITH 100mV THRESHOLD
   COMMON-MODE INPUT AT GROUND OR
- COMMON-MODE INPUT AT GROUND OR TO 40V
- COMPLEMENTARY OUTPUTS
- AUTOMATIC RESET FROM PWM CLOCK
- 180ns DELAY
- INTERFACE DIRECT TO SG1524, SG1525A, SG1527A

### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### PACKAGE PIN OUTS

> M & Y PACKAGE (Top View)

PACKAGE ORDER INFORMATION		
T <sub>A</sub> (°C)	Y Ceramic DIP 8-pin	M Plastic DIP 8-pin
0 to 70	SG3549Y	SG3529M
-25 to 85	SG2549Y	· SG2549M
-55 to 125	SG1549Y	_
MIL-STD-883	SG1549Y/883B	_
DESC	SG1549Y/DESC	_

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## SG1626/SG2626/SG3626

DUAL HIGH-SPEED DRIVER

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

The SG1626, SG2626, SG3636 is a dual inverting monolithic high speed driver that is pin-for-pin compatible with the DS0026, TSC426 and ICL7667. This device utilizes high voltage Schottky logic to convert TTL signals to high speed outputs up to 18V. The totem pole outputs have 3A peak current capability, which enables them to drive 1000pF loads in typically less than 25ns. These speeds make it ideal for driving power MOSFETs and other

large capacitive loads requiring high speed switching.

In addition to the standard packages, Linfinity offers the 16-pin SOIC (DW package) for commercial and industrial applications, and the Hermetic TO-66 (R package) for military use. These packages offer improved thermal performance for applications requiring high frequencies and/or high peak currents.

### KEY FEATURES

- PIN-FOR-PIN COMPATIBLE WITH DS0026, TSC426 AND ICL7667
- TOTEM POLE OUTPUTS WITH 3.0A PEAK CURRENT CAPABILITY
- SUPPLY VOLTAGE TO 22V
- RISE AND FALL TIME LESS THAN 25ns
- PROPAGATION DELAYS LESS THAN 20ns
- INVERTING HIGH-SPEED, HIGH-VOLTAGE SCHOTTKY LOGIC
- EFFICIENT OPERATION AT HIGH FREQUENCY

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### PACKAGE PIN OUTS 13 N.C. N.C. N.C. 12 OUT B OUT A 🗆 3 INA OUT A N.C. 🗆 4 GROUND IN A 🗆 5 10 | IN B INB OUT B N.C. 9 N.C. GROUND [ 8 N.C. J PACKAGE Y & M PACKAGE (Top View) (Top View) N.C. N.C. IN A I □ OUT A N.C. 14 □ V<sub>cc</sub> GROUND I ☐ GROUND GROUND T 12 ☐ GROUND N.C. 11 V V □ OUT B IN B □ N.C. N.C. DW PACKAGE (Top View)

PACKAGE ORDER INFORMATION				
T <sub>A</sub> (°C)	J Ceramic DIP 14-pin	Y Ceramic DIP 8-pin	M Plastic DIP 8-pin	DW Plastic SOIC 16-pin
0 to 70	SG3626J	SG3626Y	SG3626M	SG3626DW
-25 to 85	SG2626J	SG2626Y	SG2626M	SG2626DW
-55 to 150	SG1626J	SG1626Y	——————————————————————————————————————	_
MIL-STD-883	SG1626J/883B	SG1626Y/883B	_	_
DESC	SG1626J/DESC	SG1626Y/DESC	_	_

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3626DWT)

(Package Info / Pin Outs continued on next page)

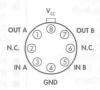
FOR FURTHER INFORMATION CALL (714) 898-8121

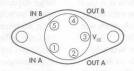
## SG1626/SG2626/SG3626

### DUAL HIGH-SPEED DRIVER

### PRODUCTION DATA SHEET

### PACKAGE PIN OUTS





CASE IS GROUND

Case & Tab are internally connected to substrate ground

T PACKAGE (Top View) R PACKAGE (Top View)



1. N.C.
2. GROUND
3. N.C.
12. N.C.
13. OUT B
4. IN A
14. N.C.
5. N.C.
6. GROUND
16. N.C.
7. N.C.
17. V<sub>CC</sub>
8. IN B
18. N.C.
9. N.C.
19. OUT A
10. GROUND
20. N.C.

L PACKAGE (Top View)

PACKAGE ORDER INFORMATION				
T <sub>A</sub> (°C)	T Metal Can TO-99 8-pin	R Metal Can TO-66 5-pin	L Ceramic (LCC) 20-pin	
0 to 70	SG3626T	SG3626R	_	
-25 to 85	SG2626T	SG2626R		
-55 to 150	SG1626T	SG1626R		
MIL-STD-883	SG1626T/883B	SG1626R/883B	SG1626L/883B	
DESC	SG1626T/DESC	SG1626R/DESC	_	





## SG1644/SG2644/SG3644

DUAL HIGH-SPEED DRIVER

THE INFINITE POWER OF INNOVATION PRODUCTION DATA SHEET

The SG1644, SG2644, SG3644 is a dual non-inverting monolithic high speed driver. This device utilizes high voltage Schottky logic to convert TTL signals to high speed outputs up to 18V. The totem pole outputs have 3A peak current capability, which enables them to drive 1000pF loads in typically less than 25ns. These speeds make it ideal for driving power MOSFETs and other large capacitive

loads requiring high speed switching. In addition to the standard packages, Linfinity offers the 16-pin SOIC (DW package) for commercial and industrial applications, and the Hermetic TO-66 (R package) for military use. These packages offer improved thermal performance for applications requiring high frequencies and/or high peak currents.

### KEY FEATURES

- TOTEM POLE OUTPUTS WITH 3.0A PEAK **CURRENT CAPABILITY**
- SUPPLY VOLTAGE TO 22V
- RISE AND FALL TIME LESS THAN 25ns
- PROPAGATION DELAYS LESS THAN 20ns
- NON-INVERTING HIGH-SPEED HIGH-VOLTAGE SCHOTTKY LOGIC
- EFFICIENT OPERATION AT HIGH **FREQUENCY**

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

N.C.   1   14   V <sub>cc</sub> N.C.   2   13   N.C.  OUT A   3   12   OUT B  PWR GND A   4   11   PWR GN  IN A   5   10   IN B  N.C.   6   9   N.C.	ND B		IN A 1 1 1 PWR GND A 2 PWR GND B 3 IN B 4	8 OUT A 7 V <sub>cc</sub> 6 LOGIC GND 5 OUT B
LOGIC GND 7 8 N.C.			TNAMEDE	0 to 70
J PACKAGE (Top View)	SG2644R SG1644R		<b>Y &amp; M F</b> (Top	PACKAGE View)
	N.C.   1   1   1   1   1   1   1   1   1	10	GROUND GROUND V <sub>cc</sub>	

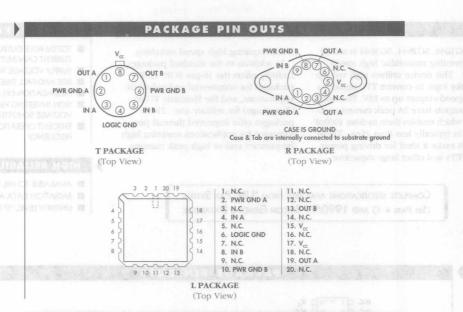
PACKAGE ORDER INFORMATION					
T <sub>A</sub> (°C)	J Ceramic DIP 14-pin	Y Ceramic DIP 8-pin	M Plastic DIP 8-pin	DW Plastic SOIC 16-pin	
0 to 70	SG3644J	SG3644Y	SG3644M	SG3644DW	
-25 to 85	SG2644J	SG2644Y	SG2644M	SG2644DW	
-55 to 150	SG1644J	SGSG1644Y	SG1644M		
MIL-STD-883	SG1644J/883B	SG1644Y/883B	SG1644M/883B	_	

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3644DWT)

## SG1644/SG2644/SG3644

### DUAL HIGH-SPEED DRIVER

## ATAS HOLT PRODUCTION DATA SHEET TO BE WORD BILLIANT SHIT



PACKAGE ORDER INFORMATION				
T <sub>A</sub> (°C)	T Metal Can TO-99 8-pin	R Metal Can TO-66 5-pin	L Ceramic (LCC) 20-pin	
0 to 70	SG3644T	SG3644R	и Са в дио жо	
-25 to 85	SG2644T	SG2644R	TRACHAGE	
-55 to 150	SG1644T	SG1644R	(well/ go/ <u>D</u>	
MIL-STD-883	SG1644T/883B	SG1644R/883B	SG1644L/883B	





## SG1825C/SG2825C/SG3825C

HIGH-SPEED CURRENT-MODE PWM

THE INFINITE POWER OF INNOVATIONS NOT RECOMMENDED FOR NEW DESIGNS

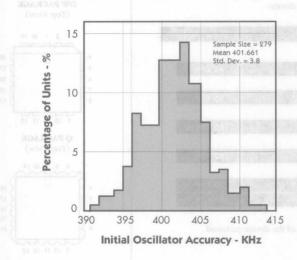
### DESCRIPTION

The SG1825C is a high-performance pulse width modulator optimized for high frequency current-mode power supplies. Included in the controller are a precision voltage reference, micropower start-up circuitry, softstart, high-frequency oscillator, wideband error amplifier, fast currentlimit comparator, full double-pulse suppression logic, and dual totempole output drivers. Innovative circuit design and an advanced linear Schottky process result in very short propagation delays through the

current limit comparator, logic, and output drivers. This device can be used to implement either currentmode or voltage-mode switching power supplies. It also is useful as a series-resonant controller to frequencies beyond 1MHz. The SG1825C is specified for operation No over the full military ambient temperature range of -55°C to 125°C. The SG2825C is characterized for the industrial range of -25°C to 85°C, and the SG3825C is selected for the commercial range of 0°C to 70°C.

#### PRODUCT HIGHLIGHT

### INITIAL OSCILLATOR ACCURACY



#### KEY FEATURES

- IMPROVED REFERENCE INITIAL TOLERANCE (±1% max.)
- IMPROVED OSCILLATOR INITIAL ACCURACY (±3% typ.)
- IMPROVED STARTUP CURRENT (500µA typ.)
- PROP DELAY TO OUTPUTS (50ns typ.)
- 10V TO 30V OPERATION
- 5.1V REFERENCE TRIMMED TO ±1%
- 2MHZ OSCILLATOR CAPABILITY
- 1.5A PEAK TOTEM-POLE DRIVERS
- U.V. LOCKOUT WITH HYSTERESIS
- NO OUTPUT DRIVER "FLOAT"
- PROGRAMMABLE SOFTSTART
- DOUBLE-PULSE SUPPRESSION LOGIC
- WIDEBAND LOW-IMPEDANCE ERROR AMPLIFIER
- ☐ CURRENT-MODE OR VOLTAGE-MODE CONTROL
- WIDE CHOICE OF HIGH-FREQUENCY

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- LINFINITY LEVEL "S" PROCESSING AVAIL.

PACKAGE ORDER INFORMATION							
T, (°C)	N Plastic DIP 16-pin	DW Plastic Wide SOIC 16-pin	Q Plastic LCC 20-pin	J Ceramic DIP 16-pin	L Ceramic LCC 20-pin		
0 to 70	SG3825CN	SG3825CDW	SG3825CQ	SG3825CJ	_		
-25 to 85	SG2825CN	SG2825CDW	SG2825CQ	SG2825CJ	_		
-55 to 125	-3	_		SG1825CJ	SG1825CL		
MIL-STD-883	TRAJETSOE OF	_	_	SG1825CJ/883B	SG1825CL/883B		
DESC	-	_		SG1825CJ/DESC	SG1825CL/DESC		

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. \$G3825CDWT)

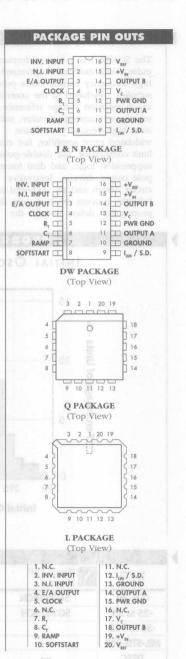
#### HIGH-SPEED CURRENT-MODE PWM

#### ENDIZED WEN HOT CERMNOT RECOMMENDED FOR NEW DESIGNS TO REWORD BELLEVIL BET

ABSOLUTE MAXIMUM RATINGS	(Note 1)
Input Voltage (V <sub>IN</sub> and V <sub>C</sub> )	30V
114	
	0.3V to 7.0V
Softstart and I / S.D.	0.3V to 6.0V
	1.5V to 6.0V
	0.3V to V <sub>c</sub> +1.5V
Source / Sink Output Current (each output):	
	0.5A
Pulse, 500ns	
Clock Output Current	5mA
	5mA
A Deal Call & Control of the Call and C	5mA
Hermetic (J, L Package)	
	150°C
Storage Temperature Range	65°C to 150°C
Lead Temperature (soldering, 10 seconds)	300°C
Note 1. Exceeding these ratings could cause damage to the device	re.

THERMAL DATA	
N PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	65°C/W
DW PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	95°C/W
Q PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{\mathrm{JA}}}$	80°C/W
J PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	80°C/W
L PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO CASE, $\theta_{_{JC}}$	35°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	120°C/W

Junction Temperature Calculation:  $T_J = T_A + (P_D \times \theta_{JA})$ . The  $\theta_{JA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.





## HIGH-SPEED CURRENT-MODE PWM

#### NOT RECOMMENDED FOR NEW DESIGNS

Parameter		Symbol	Recommen	Units		
raidiletei		Symoon	Min.	Тур.	Max.	01111
Supply Voltage Range			10	(6 sucat) a	30	V
Voltage Amp Common Mode Range		VERS COT	1.5		5.5	٧
Ramp Input Voltage Range		VC.	0		5.0	V
Current Limit / Shutdown Voltage Range		Ve	0		4.0	٧
Source / Sink Output Current		VALG	T = cont _ con		Miso gool	19 QD QQ
Continuous	VERS BARRY	PERSONAL SERVICE	GEST TOVO	200	MAXIC REJECTION	mA
Pulse, 500ns		F TOTAL TURE	and a "A	1.0	notasjen (inc.	A
Voltage Reference Output Current			1		10	mA
Oscillator Frequency Range			4		1500	kHz
Oscillator Charging Current		AVIIC	0.030		3	mA
Oscillator Timing Resistor		R <sub>T</sub>	2 1 1		100	kΩ
Oscillator Timing Capacitor		C <sub>T</sub>	0.470	(6 33	10	nF
Operating Ambient Temperature Range:				I was a second	(E BSOV) 9	SIRVY KUR
SG1825C		T <sub>A</sub>	0	S C above) move	70	°C
SG2825C	Marille Marie	TA	-25		85	O.C
SG3825C		T <sub>A</sub>	-55		125	°C

#### Note 2. Range over which the device is functional.

#### ELECTRICAL CHARACTERISTICS (Note 3)

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for SG3825C with 0°C  $\leq$  T<sub>A</sub>  $\leq$  70°C, SG2825C with -25°C  $\leq$  T<sub>A</sub>  $\leq$  85°C, SG1825C with -55°C  $\leq$  T<sub>A</sub>  $\leq$  125°C, and V<sub>IN</sub>=V<sub>C</sub>=15V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	SG1	825C/2	825C	S	Units		
raidilletei	Sylliooi	Test conditions	Min.	Тур.	Max.	Min.	Тур.	Max.	Units
Reference Section									
Output Voltage	13.11	T <sub>J</sub> = 25°C, I <sub>L</sub> = 1mA	5.05	5.10	5.15	5.05	5.10	5.15	V
Line Regulation		V <sub>IN</sub> = 10 to 30V		2	15	() JUNG	2	15	mV
Load Regulation		I <sub>L</sub> = 1 to 10mA	(free	5	15	ottos	5	15	mV
Temperature Stability (Note 3)		Over Operating Temperature		0.2	0.4		0.2	0.4	mV/°C
Total Output Range (Note 3)		Over Line, Load, and Temperature	5.00	1.36	5.20	5.00		5.20	٧
Output Noise Voltage (Note 3)	1.61	f = 10Hz to 10kHz, I <sub>L</sub> = 0mA		50	200	1	50	appl is	µV <sub>RMS</sub>
Long Term Stability (Notes 3 &4)	0.81	T <sub>J</sub> = 125°C, t = 1000hrs		5	25		5	25	mV
Short Circuit Current		V <sub>REF</sub> = OV	-15	-50	-100	-15	-50	-100	mA
Oscillator Section (Note 5)		3c000f = ,0			(E 516)	() sm	T Rei	it Rise	Опар
Initial Accuracy		$T_J = 25$ °C, $C_{CLK} \le 10$ pF	370	400	430	370	400	430	kHz
Voltage Stability	8.8	V <sub>IN</sub> = 10 to 30V		0.2	2	5961	0.2	2	%
Temperature Stability (Note 3)	10 N	Over Rated Operating Temperature		5	8	plan	5	8	%
Total Frequency Limits (Note 3)		Over Line and Temperature	350	12 64	450	350	hero.	450	kHz
Minimum Frequency		$R_T = 100K\Omega$ , $C_T = 0.01\mu F$		1	4		Die	4	kHz
Maximum Frequency		$R_T = 1K\Omega$ , $C_T = 470pF$	1.5			1.5		-	MHz
Clock High Level		$I_{CLK} = -1 \text{mA}$	3.9	4.5		3.9	4.5		٧
Clock Low Level		$I_{CLK} = -1 \text{mA}$	1	2.3	2.9	PART N	2.3	2.9	٧
Ramp Peak Voltage			2.6	2.8	3.0	2.6	2.8	3.0	V
Ramp Valley Voltage		addit orgal to one oscillator period	0.7	1.0	1.25	0.7	1.0	1.25	8 V
Valley-to-Peak Amplitude		vise spoolies]	1.6	1.8	2.0	1.6	1.8	2.0	V

Note 3. This parameter is guaranteed by design and process control, but is not 100% tested in production.

Note 4. This parameter is non-accumulative, and represents the random fluctuation of the reference voltage within some error band when observed over any 1000 hour period of time.



## HIGH-SPEED CURRENT-MODE PWM

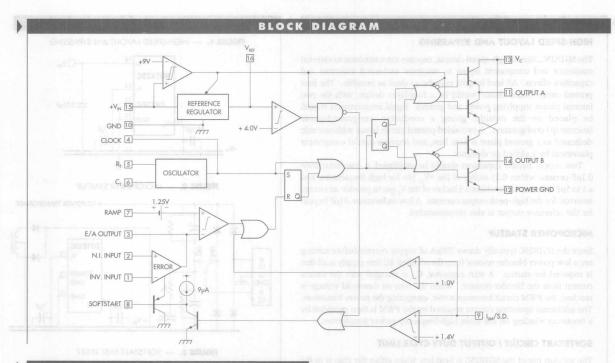
#### NOT RECOMMENDED FOR NEW DESIGNS

Parameter	Cumbal	Test Conditions	SG18	325C/2	825C	5	G3825	)(	Unit
Parameter	Symbol	Test collations	Min.	Тур.	Max.	Min.	Тур.	Max.	Unit
Error Amplifier Section (Note 6)		01				52	er Ran	atioV v	Suppl
nput Offset Voltage		$R_S \le 2K\Omega$ , $V_{ERROR} = 2.5V$		Spr	15	88.7160	mo)	15	mV
nput Bias Current		$V_{ERROR} = 2.5V$		0.6	3	ones :	0.6	3	μА
nput Offset Current		$V_{ERROR} = 2.5V$	9	0.1	1	TWOO	0.1	1	μА
OC Open Loop Gain	A <sub>VOL</sub>	V <sub>ERROR</sub> = 1 to 4V	60	95	37130	60	95	Ini2 \s	dB
Common Mode Rejection		Over Rated Voltage Range, V <sub>ERROR</sub> = 2.5V	75	95		75	95	iounit	dB
Power Supply Rejection		$V_{IN} = 10V \text{ to } 30V, V_{ERROR} = 2.5V$	85	110		85	110	e 500	dB
Output Sink Current		V <sub>ERROR</sub> = 1V	1	2.5	muD s	1.0	2.5	sist s	m/
Output Source Current		V <sub>ERROR</sub> = 4V	-0.5	-1.3	- 68	-0.5	-1.3	stor En	m/
Output High Voltage		I <sub>ERROR</sub> = -0.5mA	4.0	4.7	5.0	4.0	4.7	5.0	V
Output Low Voltage		I <sub>ERROR</sub> = 1mA	0	0.5	1.0	0	0.5	1.0	W V
Jnity Gain Bandwidth (Note 3)		$A_{\text{VOL}} = 0 \text{dB}$	3	5.5	30	3	5.5	uT not	MH
Slew Rate (Note 3)			6	penall s	Bullans	6	nskin	A anii	V/µs
PWM Comparator Section (Note	5 & 7)								
Ramp Input Bias Current		-25		-1	-5		-1	-5	AHSO
Minimum Duty Cycle		V <sub>ERROR</sub> = 1V			0			0	%
Maximum Duty Cycle (Note 8)		V <sub>ERROR</sub> = 4V	85	65/98	ts with	85	250/45 5	Barrell	%
Zero Duty Cycle Threshold			1.1	1.25		1.1	1.25		٧
Delay to Driver Output (Note 3)	S A FEW S	V <sub>RAMP</sub> = 0V to 2V, V <sub>ERROR</sub> = 2V	7 35	50	80	Till e	50	80	ns
Softstart Section	CUC PV2 SV2				and the last	A STATE OF THE PARTY OF THE PAR	Section 1	- Andrew	
Css Charge Current	current print	V <sub>SOFTSTART</sub> = 0.5V	3	9	20	3	9	20	ЦА
Css Discharge Current		V <sub>SOFTSTART</sub> = 1.0V	1198	INE UNI	Fot In	110	nutero	mor 5	m/
Current Limit / Shutdown Section	(Note 9)		THE REAL PROPERTY.	1		1000			3-21
Im Input Bias Current	(1.000 )		1	T COST	±15			±10	ЦА
Current Limit Threshold	Colonia Colonia		0.9	1.0	1.1	0.9	1.0	1.1	V
Shutdown Threshold	20 XI	Ant7 = 1 3°90 = Y	1.25	1.40	1.55	1.20	1.40	1.55	V
Delay to Driver Output (Note 3)		V <sub>SHUTDOWN</sub> = 0V to 1.2V	1	50	80	7.20	50	80	ns
Output Drivers Section (each ou	tnut)	SHUTDOWN = 0 · CO 112 ·	_					Blues/	I ban I
Output Low Level	tput)	I - 00m A Studenson of the Control o	1	0.25	0.40	DB 98	0.25	0.40	V
Sutput Low Level	10.2	I <sub>SINK</sub> = 20mA	-	1.2	2.0	nid)	1.2	2.0	V
Output High Lovel		I <sub>SINK</sub> = 200mA	120		2.0	12.0		2.0	V
Output High Level	-	I <sub>SOURCE</sub> = 20mA	13.0	13.5	68 E 28	13.0	13.5	D remail	V
/, Standby Current	28-	$I_{\text{SOURCE}} = 200\text{mA}$ $V_c = 30\text{V}$	12.0	150	500	12.0	150	500	UА
Output Rise / Fall Time (Note 3)		$V_c = 30V$ $C_1 = 1000pF$		30	60	100	30	60	ns
	nee 1	C <sub>L</sub> = 1000pr	_	30	.00	17 14	30		115
Undervoltage Lockout Section	000	John Charles Will	1				27.411	ACCUIN	STEAL PROPERTY.
Start Threshold Voltage		TOU WITH A PROPERTY OF THE PRO	8.8	9.2	9.7	8.8	9.2	9.7	V
JV Lockout Hysteresis	100	Over Reted Operating Temperature	0.4	0.8	1.2	0.4	0.8	1.2	V
Supply Current Section (Note 5)	Disc	SILITE SCHOOL STEEL TONG			C SHOT	17 cann	net Ami	supar	10201
Start Up Current		$V_{IN} = 8V$		0.5	1.2	- 3	0.5	1.2	mA
Operating Current	0.0	$V_{INV}$ , $V_{RAMP}$ , $V(I_{LIM}/S.D.) = 0V$ , $V_{N.I.} = 1V$		22	33	-	22	33	m/
ote 5. $F_{OSC} = 400 \text{kHz} (R_T = 3.65 \text{k}\Omega, C_T)$ ote 6. $V_{CM} = 1.5 \text{V}$ to 5.5 V.	= 1.0 nF).								



#### HIGH-SPEED CURRENT-MODE PWM

#### NOT RECOMMENDED FOR NEW DESIGNS

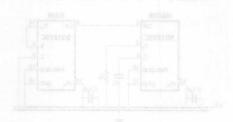


#### FIGURE INDEX

#### **Application Circuits**

#### FIGURE !

- 1. HIGH-SPEED LAYOUT AND BYPASSING
- 2. MICROPOWER STARTUP
- 3. SOFTSTART FAST RESET
- 4. OSCILLATOR SYCHRONIZATION
- 5. OSCILLATOR FUNCTIONAL DIAGRAM
- 6. VOLTAGE AMPLIFIER CONNECTIONS
- 7. DRIVING SHIELDED CABLE



who or three SGIESSC oscillators with the Jocked together with the

netconnection scheme shown. If the devices are within an arch or so of ach other. A master unit is programmed for desired frequency with R, and a own. The oscillators in the slave units are dischled by grounding C, and by connecting R, to V<sub>sin</sub>. The logic in the slave units is locked to the lock of the master with the wire-OR connection shown.

menty workers our net requestive a minute spread tools to warmy cilly one as stave units, and distributing the master clock to wash usin section our genmenty.

#### APPLICATION INFORMATION

#### HIGH-SPEED LAYOUT AND BYPASSING

The SG1825C, like all high-speed circuits, requires extra attention to external conductor and component layout to minimize undesired inductive and capacitive effects. All lead lengths must be as short as possible. The best printed circuit board choice would be a four-layer design, with the two internal planes supplying power and ground. Signal interconnects should be placed on the outside, giving a conductor-over-ground-plane (microstrip) configuration. A two-sided printed circuit board with one side dedicated as a ground plane is next best, and requires careful component placement by a skilled pc designer.

Two supply bypass capacitors should be employed: a low-inductance 0.1  $\mu F$  ceramic within 0.25 inches of the +V $_{\rm IN}$  pin for high frequencies, and a 1 to 5  $\mu F$  solid tantalum within 0.5 inches of the V $_{\rm C}$  pin to provide an energy reservoir for the high-peak output currents. A low-inductance .01  $\mu F$  bypass for the reference output is also recommended.

#### MICROPOWER STARTUP

Since the SG1825C typically draws 700 $\mu$ A of supply current before turning on, a low power bleeder resistor from the rectified AC line supply is all that is required for startup. A start capacitor,  $C_s$ , is charged with the excess current from the bleeder resistor. When the turn-on threshold voltage is reached, the PWM circuit becomes active, energizing the power transistors. The additional operating current required by the PWM is then provided by a bootstrap winding on the main high-frequency power transformer.

#### SOFTSTART CIRCUIT / OUTPUT DUTY CYCLE LIMIT

The softstart pin of the SG1825C is held low when either the chip is in the micropower mode, or when a voltage greater than +1.4 volts is present at the  $I_{\rm LIM/N.D.}$  pin. The maximum positive swing of the voltage error amplifier is clamped to the Softstart pin voltage, providing a ramp-up of peak charging currents in the power semiconductors at turn-on.

In some cases, the duration of the Shutdown signal can be too short to fully discharge the softstart capacitor. The illustrated resistor/discrete PNP transistor configuration can be used to shorten the discharge time by a factor of 50 or more. When the internal discharge transistor in the SG1825C turns on, current will flow through surge limit resistor R1. As the resistor drop approaches 0.6 volts, the external PNP turns on, providing a low resistance discharge path for the energy in the softstart capacitor. The capacitor will be rapidly discharged to +0.7 volts, which corresponds to zero duty cycle in the pulse width modulator.

#### FREQUENCY SYNCHRONIZATION

Two or three SG1825C oscillators may be locked together with the interconnection scheme shown, if the devices are within an inch or so of each other. A master unit is programmed for desired frequency with  $R_{\tau}$  and  $C_{\tau}$  as usual. The oscillators in the slave units are disabled by grounding  $C_{\tau}$  and by connecting  $R_{\tau}$  to  $V_{\text{REF}}$ . The logic in the slave units is locked to the clock of the master with the wire-OR connection shown.

Many SG1825Cs can be locked to a master system clock by wiring the oscillators as slave units, and distributing the master clock to each using a tree-fanout geometry.

#### APPLICATION FIGURES

FIGURE 1. — HIGH-SPEED LAYOUT and BYPASSING

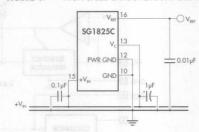


FIGURE 2. — MICROPOWER STARTUP

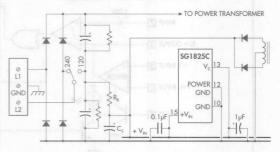


FIGURE 3. — SOFTSTART FAST RESET

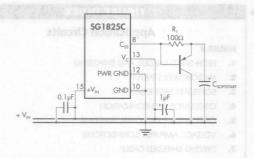
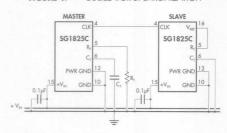


FIGURE 4. — OSCILLATOR SYCHRONIZATION





#### HIGH-SPEED CURRENT-MODE PWM

#### NOT RECOMMENDED FOR NEW DESIGNS

#### APPLICATION INFORMATION

#### **OSCILLATOR**

The oscillator frequency is programmed by external timing components  $R_{\tau}$  and  $C_{\tau^*}$ . A nominal +3.0 volts appears at the  $R_{\tau}$  pin. The current flowing through  $R_{\tau}$  is mirrored internally with a 1:1 ratio. This causes an identical current to flow out the  $C_{\tau}$  pin, charging the timing capacitor and generating a linear ramp. When the upper threshold of +2.8 volts is reached, a discharge network reduces the ramp voltage to +1.0, where a new charge cycle begins.

The Clock output pin is LOW (+2.3 volts) during the charge cycle, and HIGH (+4.5 volts) during the discharge cycle. The Clock pin is driven by an NPN emitter follower, and so can be wire-ORed. Each Clock pin can drive a ImA load. Since the internal current-source pulldown is approximately 400uA, the DC fan-out to other SG1825C Clock pins is at least two.

The type of capacitor selected for  $C_T$  is very important. At high frequencies, non-ideal characteristics such as effective series resistance (ESR), effective series inductance (ESL), dielectric loss and dielectric absorption all affect frequency accuracy and stability. RF capacitors such as silver mica, glass, polystrene, or COG ceramics are recommended. Avoid high-K ceramics, which work best in DC bypass applications.

#### ERROR AMPLIFIER

The voltage error amplifier is a true operational amplifier with low-impedance output, and can be gain-stabilized using conventional feedback techniques. The typical DC open-loop gain is 95dB, with a single low-frequency pole at 100Hz.

The input connections to the error amplifier are determined by the polarity of the power supply output voltage. For positive supplies, the common-mode voltage is +5.1 volts and the feedback connections in Figure A are used. With negative outputs, the common-mode voltage is half the reference, and the feedback divider is connected between the negative output and the +5.1 volt reference as shown in Figure B.

#### **OUTPUT DRIVER**

The output drivers are designed to provide up to 1.5 Amps peak output current. To minimize ringing on the output waveform, which can be destructive to both the power MOSFET and the PWM chip, the series inductance seen by the drivers should be as low as possible.

One solution is to keep the distance between the PWM and MOSFET gate as short as possible, and to use carbon composition series damping resistors. A Faraday shield to intercept radiated EMI from the power transistors is usually required with its choice.

A second approach is to place the MOSFETs some distance from the PWM chip, and use a series-terminated transmission line to preserve drive pulse fidelity. This will minimize noise radiated back to the sensitive analog circuitry of the SG1825C. A Faraday shield may also be required.

If the drivers are connected to an isolation transformer, or if kickback through  $C_{\rm GD}$  of the MOSFET is severe, clamp diodes may be required. 1 Amp peak Schottky diodes will limit undershoot to less than -0.3 volts.

#### **APPLICATION FIGURES**

FIGURE 5. — OSCILLATOR FUNCTIONAL DIAGRAM

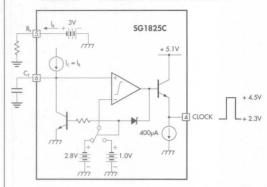


FIGURE 6. — VOITAGE AMPLIFIER CONNECTIONS

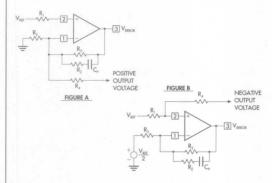
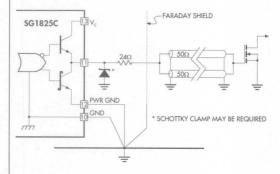


FIGURE 7. — DRIVING SHIELDED CABLE





## Notes

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PROTEST VORINGE AWAY FIEL CONVECTORS

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The input connections to the open analytics and discussional by also polarity of the compact voltage. This positive supplies the commencement contage is +3.1 was and the security compactants of the regarder analytic of a contage of the contage of

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CURRENT MODE PWM CONTROLLER

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

The SG1842/43 family of control IC's provides all the necessary features to implement off-line fixed frequency, current-mode switching power supplies with a minimum number of external components. Current-mode architecture demonstrates improved line regulation, improved load regulation, pulse-by-pulse current limiting and inherent protection of the power supply output switch.

The bandgap reference is trimmed to ±1% over temperature. Oscillator discharge current is trimmed to less than ±10%. The SG1842/43 has under-

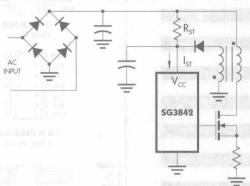
voltage lockout, current limiting circuitry and start-up current of less than 1mA.

The totem-pole output is optimized to drive the gate of a power MOSFET. The output is low in the off state to provide direct interface to an N channel device.

The SG1842/43 is specified for operation over the full military ambient temperature range of -55°C to 125°C. The SG2842/43 is specified for the industrial range of -25°C to 85°C, and the SG3842/43 is designed for the commercial range of 0°C to 70°C.

#### PRODUCT HIGHLIGHT

TYPICAL APPLICATION OF SG3842 IN A FLYBACK CONVERTER



#### KEY FEATURES

- OPTIMIZED FOR OFF-LINE CONTROL
- LOW START-UP CURRENT (<1mA)
- AUTOMATIC FEED FORWARD COMPENSATION
- TRIMMED OSCILLATOR DISCHARGE CURRENT
- PULSE-BY-PULSE CURRENT LIMITING
- ENHANCED LOAD RESPONSE CHARACTERISTICS
- UNDER-VOLTAGE LOCKOUT WITH 6V HYSTERESIS (SG1842 only)
- DOUBLE-PULSE SUPPRESSION
- HIGH-CURRENT TOTEM-POLE OUTPUT (1AMP PEAK)
- INTERNALLY TRIMMED BANDGAP REFERENCE
- 500KHZ OPERATION
- UNDERVOLTAGE LOCKOUT SG1842 - 16 volts SG1843 - 8.4 volts
- LOW SHOOT-THROUGH CURRENT <75mA OVER TEMPERATURE

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- SCHEDULED FOR MIL-M38510 QPL LISTING
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

			PACKAGE	ORDER I	NFORMAT	ION		
T <sub>A</sub> (°C)	M Ceramic DIP 8-pin	N Plastic DIP 14-pin	DM Plastic SOIC 8-pin	D Plastic SOIC 14-pin	Y Ceramic DIP 8-pin	J Ceramic DIP 14-pin	F Cer. Flatpack	L Ceramic LCC 20-pin
01.70	SG3842M	SG3842N	SG3842DM	SG3842D	SG3842Y	SG3842J		
0 to 70	SG3843M	SG3843N	SG3843DM	SG3843D	SG3843Y	SG3843J	Smile - trough	or or testing to
-25 to 85	SG2842M	SG2842N	SG2842DM	SG2842D	SG2842Y	SG2842J	PATROLIN LA RESEL	0.4 , / <u>0.2</u> 7 ,
-23 to 83	SG2843M	SG2843N	SG2843DM	SG2843D	SG2843Y	SG2843J	_	_
55 1- 105	mm x - 15 /	- 1		_	SG1842Y	SG1842J	_	SG1842L
-55 to 125	201 1 + 7 (			7.9 <u>— 1</u> 9.0	SG1843Y	SG1843J		SG1843L
AAII CTD /002	27,3 .0		-	_	SG1842Y/883B	SG1842J/883B	<del></del>	SG1842L/883B
MIL-STD/883	3.2430364	_	_	_	SG1843Y/883B	SG1843J/883B	_	SG1843L/883B
DESC	1 1 2 5 V 1 1 5 V	_			SG1842Y/DESC	SG1842J/DESC	SG1842F/DESC	SG1842L/DESC
DESC			_	_	SG1843Y/DESC	SG1843J/DESC	SG1843F/DESC	SG1843L/DESC

Note: All surface-mount packages are available in Tape & Reel.

terminal.

#### CURRENT-MODE PWM CONTROLLER

#### PRODUCTION DATA SHEET

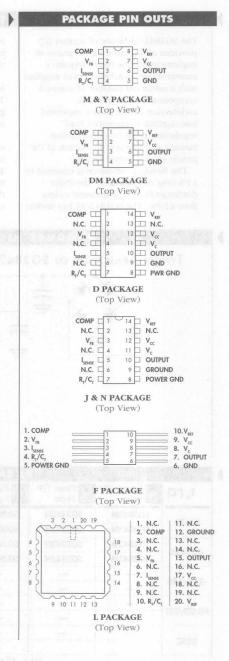
ABSOLUTE MAXIMUM RATINGS (Notes 1 & 2)
Supply Voltage (I <sub>CC</sub> < 30mA)
Supply Voltage (Low Impedance Source)
Output Current (Peak)
Output Current (Continuous)
Output Energy (Capacitive Load)
Analog Inputs (Pins 2, 3)0.3V to +6.3V
Error Amp Output Sink Current
Power Dissipation at T <sub>4</sub> = 25°C (DIL-8)
Operating Junction Temperature
Hermetic (J, Y, F, L Packages)
Plastic (N, M, D, DM Packages)
Storage Temperature Range65°C to +150°C
Lead Temperature (Soldering, 10 Seconds)
Note 1. Exceeding these ratings could cause damage to the device.

Note 2. All voltages are with respect to Pin 5. All currents are positive into the specified

#### THERMAL DATA M PACKAGE: THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{ij}$ THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{ij}$ THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{ij}$ 165°C/W THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{ij}$ Y PACKAGE: THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{ij}$ J PACKAGE: THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{ij}$ 80°C/W THERMAL RESISTANCE-JUNCTION TO CASE, $\theta_{jo}$ THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta$ 145°C/W THERMAL RESISTANCE-JUNCTION TO CASE, $\theta_{ic}$ 35°C/W THERMAL RESISTANCE-JUNCTION TO AMBIENT, 0, Junction Temperature Calculation: $T_1 = T_A + (P_D \times \theta_{IA})$ .

Junction Temperature Calculation:  $I_j = I_A + C\rho_D \times \theta_{jA}$ .

The  $\theta_{jA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.



#### CURRENT-MODE PWM CONTROLLER

#### PRODUCTION DATA SHEET

Parameter	Symbol	Recommended Operating Conditions					
Farameter	Symoon	Min.	Тур.	Max.	Units		
Supply Voltage Range			30	COLDER SERVE	V		
Output Current (Peak)	23		±1	(8.8.2.25)0	A		
Output Current (Continuous)	8.0 1	The same	200	of Q. ladge? Judge of	mA		
Analog Inputs (Pin 2, Pin 3)	787	0 200	të stoffi, bise	2.6	V		
Frror Amp Output Sink Current			5	s Current	mA		
Oscillator Frequency Range		0.1		500	kHz		
Oscillator Timing Resistor	R <sub>T</sub>	0.52		150	ΚΩ		
Oscillator Timing Capacitor	C <sub>T</sub> A	0.1		1.0	μF		
Operating Ambient Temperature Range:	AG	100 ± 201					
SG1842/43 E1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	ET Am	-55		125	°C		
SG2842/43	ET ATEX	-25		85	°C		
SG3842/43	1	0		70	°C		

#### ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for SG1842/SG1843 with -55°C  $\leq$  T $_{_{A}} \leq$  125°C, SG2842/SG2843 with -25°C  $\leq$  T $_{_{A}} \leq$  85°C, SG3842/SG3843 with 0°C  $\leq$  T $_{_{A}} \leq$  70°C, V $_{_{CC}} =$  15V (Note 7), R $_{_{T}} =$  10k $\Omega$ , and C $_{_{T}} =$  3.3nF. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	SC	31842	43	SC	2842	/43	SG3842/43			Units
raidilletei	Sylliooi	Test Conditions	Min.	Тур.	Max.	Min.	Тур.	Max.	Min.	Тур.	Max.	Omt
Reference Section	10									Cycle	am Dut	rataiAA
Output Voltage		$T_{J} = 25^{\circ}C, I_{O} = 1 \text{mA}$	4.95	5.00	5.05	4.95	5.00	5.05	4.90	5.00	5.10	٧
Line Regulation		12 ≤ V <sub>IN</sub> ≤ 25V		6	20		6	20	Mile II	6	20	m٧
Load Regulation		1 ≤ I <sub>o</sub> ≤ 20mA	4 6	6	25		6	25	nonv	6	25	mV
Temperature Stability (Note 4)			Add	0.2	0.4		0.2	0.4	16.4	0.2	0.4	mV/°
Total Output Variation (Note 4)		Line, Load, Temp.	4.90		5.10	4.90		5.10	4.82		5.18	٧
Output Noise Voltage (Note 4)	V <sub>N</sub>	10Hz ≤ f ≤ 10kHz, T <sub>J</sub> = 25°C	- STATE	50	18 1137	THE PERSON	50	Stille A	101500	50	9014	μV
Long Term Stability (Note 4)	out sourty	T <sub>A</sub> = 125°C, 1000hrs	n	5	25	La contraction	5	25	au aban	5	25	m٧
Output Short Circuit			-30	-100	-180	-30	-100	-180	-30	-100	-180	mA
Oscillator Section				-17			480	H.		1 84 1		
Initial Accuracy		T <sub>J</sub> = 25°C	47	52	57	47	52	57	47	52	57	kHz
Voltage Stability		12 ≤ V <sub>cc</sub> ≤ 25V	1	0.2	1	1577	0.2	1	1 1	0.2	1	%
Temperature Stability (Note 4)		$T_{MIN} \le T_A \le T_{MAX}$		5			5		1343	5		%
Amplitude		V <sub>RT/CT</sub> (Peak to Peak)		1.7			1.7			1.7		٧
Discharge Current		T <sub>J</sub> = 25°C	7.8	8.3	8.8	7.5	8.4	9.3	7.5	8.4	9.3	mA
		$T_{MIN} \le T_A \le T_{MAX}$	7.0		9.0	7.2		9.5	7.2	193	9.5	mA
Error Amp Section					S. S. S.		1704	1	1		76	17
Input Voltage		$V_{COMP} = 2.5V$	2.45	2.50	2.55	2.45	2.50	2.55	2.42	2.50	2.58	٧
Input Bias Current				-0.3	-1		-0.3	1		-0.3	-2	μΑ
Open Loop Gain	A <sub>VOL</sub>	2 ≤ V <sub>o</sub> ≤ 4V	65	90		65	90		65	90		dB
Unity Gain Bandwidth (Note 4)		T <sub>J</sub> = 25°C	0.7	1		0.7	1		0.7	1		MHz
Power Supply Rejection Ratio	PSRR	12 ≤ V <sub>cc</sub> ≤ 25V	60	70		60	70		60	70		dB
Output Sink Current		$V_{VFB} = 2.7V, V_{COMP} = 1.1V$	2	6		2	6		2	6		mA
Output Source Current		$V_{VFB} = 2.3V, V_{COMP} = 5V$	-0.5	-0.8		-0.5	-0.8		-0.5	-0.8		mA
V <sub>out</sub> High	7	$V_{VFB} = 2.3V$ , $R_L = 15K$ to gnd	5	6		5	6		5	6		٧
V <sub>out</sub> Low		$V_{VFR} = 2.7V, R_1 = 15K \text{ to } V_{RFF}$		0.7	1.1		0.7	1.1		0.7	1.1	٧

(Electrical Characteristics continue next page.)



## CURRENT-MODE PWM CONTROLLER

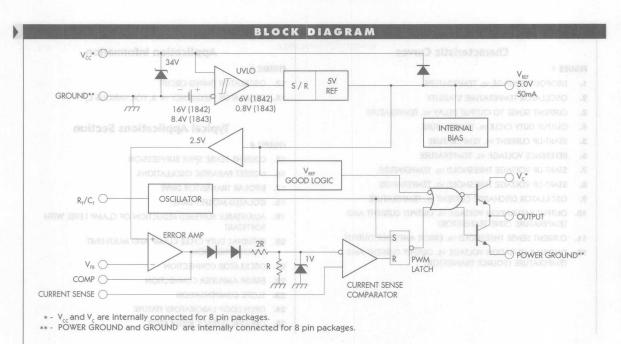
#### PRODUCTION DATA SHEET

	c	1000		dialone	SG	1842/	43	SC	2842/	43	SG	3842/	43	Units
Parameter	Symbol	Te	est Con	ditions	Commission of the last of the	SECTION AND ADDRESS.	20100	No. of Persons	Тур.	HO TO	S. B. A. S. C. S.	THE RESERVE TO SERVE	The second second	Unit
Current Sense Section											6.0	med en	a Hall b	francis
Gain (Notes 5 & 6)			1		2.85	3	3.15	2.85	3	3.15	2.85	3	3.15	V/V
Maximum Input Signal (Note 5)		V <sub>COMP</sub> =	5V		0.9	1	1.1	0.9	1	1.1	0.9	1	1.1	٧
Power Supply Rejection Ratio (Note 5)	PSRR	12 ≤ V.	cc ≤ 25V			70			70		ni0 0	70	cond to	dB
Input Bias Current	1 - 1					-2	-10		-2	-10	Subato	-2	-10	uА
Delay to Output (Note 4)		4.0	-			150	300	100	150	300	2 20 15	150	300	ns
Output Section		010	+		_	100	000	7771	100	000	natries		000	
Output Section Output Low Level		1 0	10 A		-	0.1	0.4		0.1	0.4		0.1	0.4	V
Output Low Level	-	I <sub>SINK</sub> = 9		Manager 1	-		0.4		0.1		paciti	1.5		V
Ontrod III de l'Essel		$I_{SINK} = 2$			42	1.5	2.2	40	1.5	2.2	42		2.2	V
Output High Level			= 20mA		13	13.5		13	13.5		13	13.5	Segretal	
2 1 2 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1			= 200mA		12	13.5	450	12	13.5		12	13.5	CONT.	V
Rise Time			°C, C <sub>L</sub> = '		-	50	150		50	150		50	150	ns
Fall Time		$T_{j} = 25$	°C, C <sub>L</sub> = '	1nF		50	150	THE PARTY	50	150	HILLIAN TO	50	150	ns
Under-Voltage Lockout Section				and the latest								1000	STATE OF	
Start Threshold	18 24	1842		W. M. C. S.	15	16	17	15	16	17	14.5	16	17.5	V
	\$18108	1843			7.8	8.4	9.0	7.8	8.4	9.0	7.8	8.4	9.0	V
Min. Operation Voltage After Turn-On		1842			9	10	11	9	10	11	8.5	10	11.5	٧
	(-201	1843	maidien	orb or happy	7.0	7.6	8.2	7.0	7.6	8.2	7.0	7.6	8.2	V
PWM Section		*-111	artinu a		STOLE.	100	N. Ser	5718		Mists		BUST	1/27	100
Maximum Duty Cycle			E TYPE		93	95	100	90	95	100	90	95	100	%
Minimum Duty Cycle	7 10 10 10 10	100 220			1	,,,	0	70	,,,	0	70	1/443	0	%
Power Consumption Section	105-1-4.90	2 0/1 7	THEFT			50					115	70 000		3,00
Start-Up Current	AND THE PARTY OF T	1 2000	1000	- ARREST	1000	OF	1		O.F.	1		0.5	1	i m
Operating Supply Current	1 20	V V	0)/	,	100	0.5	1 17		0.5	17		0.5	17	m/
			SENSE = OV			34	17		34	17	20. 5.31	34	17	m/
V <sub>cc</sub> Zener Voltage	SS 5 T 700	$I_{cc} = 25$	MA		Y 500	34			34	37.5	77 30	34	PHUNDAN	٧
otes: 4. These parameters, although gua	iranteed,	are not	100% tes	ted in	6. 0	ain de	fined :	as: A =	$\frac{\Delta V_{c}}{\Delta V_{IS}}$	OMP ;	0 ≤ V,	ENICE S	0.8V.	
production.					7.04	divers V	7 alas	+1	△ V IS	ENSE	1.1 1-6	EINSE	BIOM 3	1537
5. Parameter measured at trip points	at of latel	h with V	$V_{\rm VFB} = 0.$		/. A	ajust	cc abc	ve the	start i	nresno			tting at	



#### CURRENT-MODE PWM CONTROLLER

#### PRODUCTION DATA SHEET



TEMPERATURE (SOURCE TRANSISTOR)

#### CURRENT-MODE PWM CONTROLLER

#### PRODUCTION DATA SHEET

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21. OSCILLATOR CONNECTION22. ERROR AMPLIFIER CONNECTION

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SLOPE COMPENSATION
 OPEN LOOP LABORATORY FIXTURE

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FIGURE 1. — DROPOUT VOLTAGE vs. TEMPERATURE

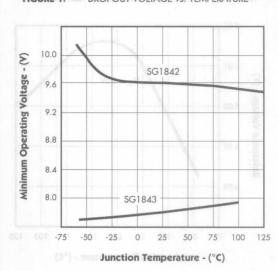
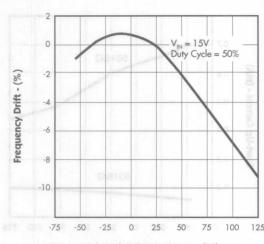


FIGURE 2. — OSCILLATOR TEMPERATURE STABILITY



Junction Temperature - (°C)

FIGURE 3. — CURRENT SENSE TO OUTPUT DELAY vs.

TEMPERATURE

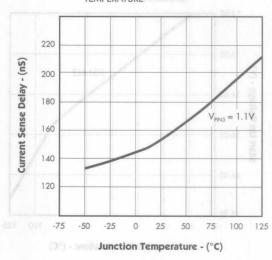
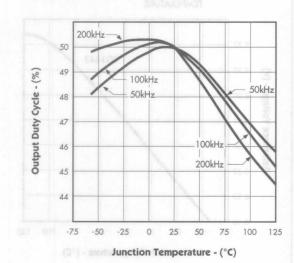


FIGURE 4. — OUTPUT DUTY CYCLE vs. TEMPERATURE





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FIGURE 5. — START-UP CURRENT VS. TEMPERATURE

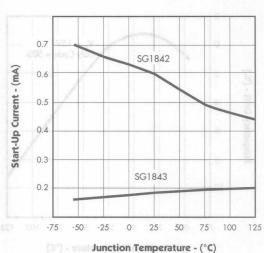


FIGURE 6. — REFERENCE VOLTAGE vs. TEMPERATURE

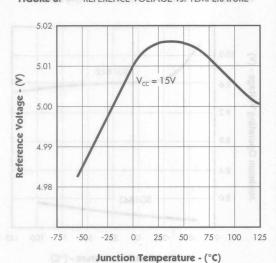


FIGURE 7. — START-UP VOLTAGE THRESHOLD vs. **TEMPERATURE** 

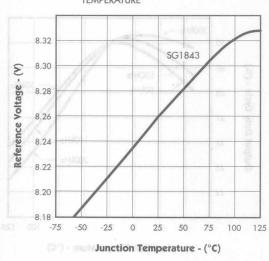
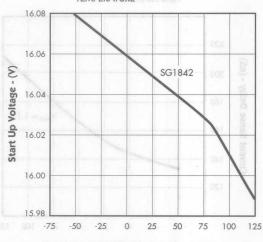


FIGURE 8. — START-UP VOLTAGE THRESHOLD vs. TEMPERATURE TABLES



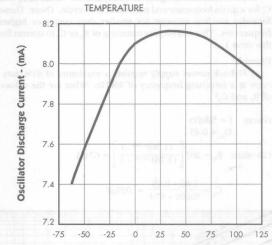




## CURRENT-MODE PWM CONTROLLER

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FIGURE 9. — OSCILLATOR DISCHARGE CURRENT vs.



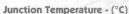


FIGURE 11. — CURRENT SENSE THRESHOLD vs. **ERROR AMPLIFIER OUTPUT** 

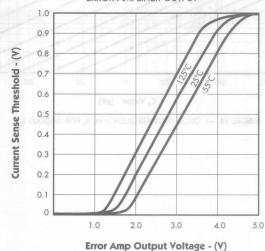


FIGURE 10. — OUTPUT SATURATION VOLTAGE vs. OUTPUT CURRENT & TEMPERATURE

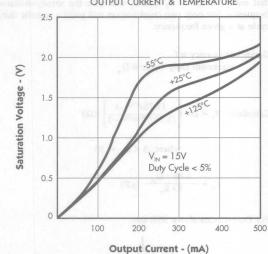
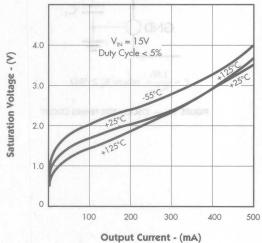


FIGURE 12. — OUTPUT SATURATION VOLTAGE vs. **OUTPUT CURRENT & TEMPERATURE** 



#### APPLICATION INFORMATION

#### OSCILLATOR

The oscillator of the 1842/43 family of PWM's is designed such that many values of  $R_T$  and  $C_T$  will give the same oscillator frequency, but only one combination will yield a specific duty cycle at a given frequency.

Given: Frequency ≡ f

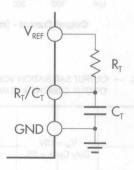
Maximum Duty Cycle ≡ D

Calculate: 
$$R_T = 267 \left[ \frac{(1.76)^{1/D_m} - 1}{(1.76)^{(1-D_m)/D_m} - 1} \right] (\Omega)$$

where 
$$.3 < D_m < .95$$

$$C_{_{\rm T}} = \frac{1.86 * D_{_{\rm m}}}{f * R_{_{\rm T}}} (\mu F)$$

For Duty-Cycles above 95% use:



$$F \approx \frac{1.86}{R_{\tau}C_{\tau}}$$
 where  $R_{\tau} \ge 5k\Omega$ 

FIGURE 13 — OSCILLATOR TIMING CIRCUIT

A set of formulas are given to determine the values of  $R_T$  and  $C_T$  for a given frequency and maximum duty cycle. (Note: These formulas are less accurate for smaller duty cycles or higher frequencies. This will require trimming of  $R_T$  or  $C_T$  to correct for this error.)

Example:

A Flyback power supply requires a maximum of 45% duty cycle at a switching frequency of 50kHz. What are the values of R<sub>\*</sub> and C<sub>\*</sub>?

Given: f = 50kHz

$$D_{m} = 0.45$$

Calculate: 
$$R_r = 267 \left[ \frac{(1.76)^{1/.045} - 1}{(1.76)^{.55/.45} - 1} \right] = 674\Omega$$

$$C_{T} = \frac{1.86 * 0.45}{50000 * 674} = .025 \mu F$$

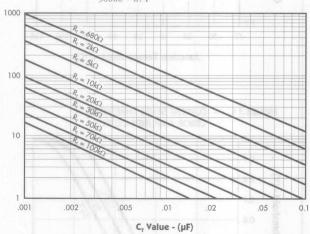


FIGURE 14 — OSCILLATOR FREQUENCY vs. R. FOR VARIOUS C.

#### CURRENT-MODE PWM CONTROLLER

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#### TYPICAL APPLICATION CIRCUITS

Pin numbers referenced are for 8-pin package and pin numbers in parenthesis are for 14-pin package.

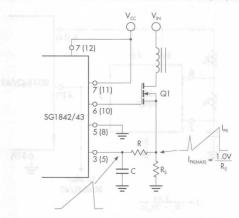
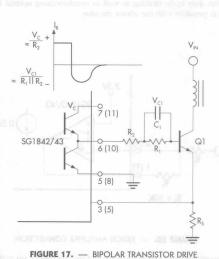


FIGURE 15. — CURRENT-SENSE SPIKE SUPPRESSION

The RC low pass filter will eliminate the leading edge current spike caused by parasitics of Power MOSFET.



The 1842/43 output stage can provide negative base current to remove base charge of power transistor  $(Q_1)$  for faster turn off. This is accomplished by adding a capacitor  $(C_1)$  in parallel with a resistor  $(R_1)$ . The resistor  $(R_2)$  is to limit the base current during turn on.

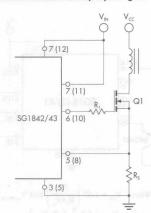


FIGURE 16. — MOSFET PARASITIC OSCILLATIONS

A resistor ( $R_{\rm p}$ ) in series with the MOSFET gate reduce overshoot and ringing caused by the MOSFET input capacitance and any inductance in series with the gate drive. (Note: It is very important to have a low inductance ground path to insure correct operation of the I.C. This can be done by making the ground paths as short and as wide as possible.)

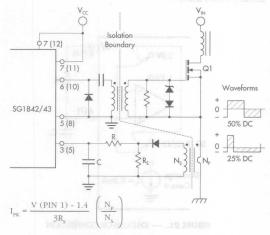


FIGURE 18. — ISOLATED MOSFET DRIVE

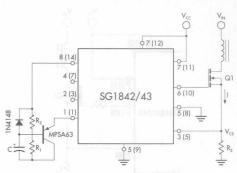
Current transformers can be used where isolation is required between PWM and Primary ground. A drive transformer is then necessary to interface the PWM output with the MOSFET.



#### CURRENT-MODE PWM CONTROLLER

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#### TYPICAL APPLICATION CIRCUITS (continued)



$$\begin{split} &I_{PK} = \frac{V_{CS}}{R_S} \text{ Where: } V_{CS} = 1.67 \left(\frac{R_1}{R_1 + R_2}\right) \text{and } V_{CS,MAX} = 1V \text{ (Typ.)} \\ &t_{SOFTSTART} = -ln \left[1 - \frac{V_{EAO} - 1.3}{5 \left(\frac{R_1}{R_1 + R_2}\right)}\right] \left(\frac{R_1}{R_1 + R_2}\right) C \end{split}$$

where;  $V_{EAO} \equiv$  voltage at the Error Amp Output under minimum line and maximum load conditions.

## FIGURE 19. — ADJUSTABLE BUFFERED REDUCTION OF CLAMP LEVEL WITH SOFTSTART

Softstart and adjustable peak current can be done with the external circuitry shown above.

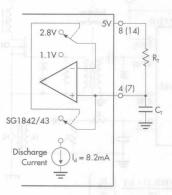
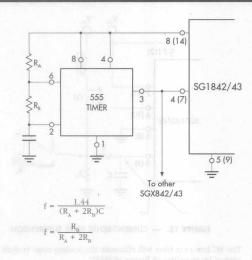


FIGURE 21. — OSCILLATOR CONNECTION

The oscillator is programmed by the values selected for the timing components  $R_T$  and  $C_T$ . Refer to application information for calculation of the component values.



## FIGURE 20. — EXTERNAL DUTY CYCLE CLAMP AND MULTI-UNIT SYNCHRONIZATION

Precision duty cycle limiting as well as synchronizing several 1842/1843's is possible with the above circuitry.

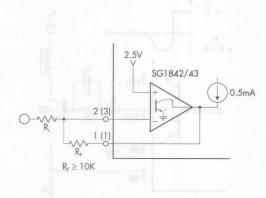


FIGURE 22. — ERROR AMPLIFIER CONNECTION

Error amplifier is capable of sourcing and sinking current up to 0.5mA.

#### CURRENT-MODE PWM CONTROLLER

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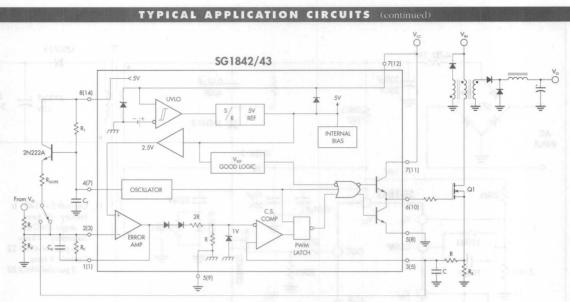


FIGURE 23. — SLOPE COMPENSATION

Due to inherent instability of current mode converters running above 50% duty cycle, a slope compensation should be added to either current sense pin or the error amplifier. Figure 23 shows a typical slope compensation technique.

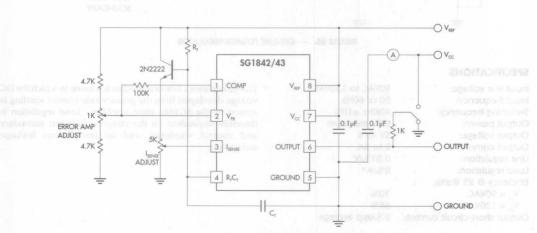


FIGURE 24. — OPEN LOOP LABORATORY FIXTURE

High-peak currents associated with capacitive loads necessitate careful grounding techniques. Timing and bypass capacitors should be connected to pin 5 in a single point ground. The transistor and 5k potentiometer are used to sample the oscillator waveform and apply an adjustable ramp to pin 3.



#### TYPICAL APPLICATION CIRCUITS (continued) TI USD735 4.7Ω 1W 220µF 0.01pF 250V 400V 4700µF ± 5V 673-3 2-5A 10V 1W 1N3613 AC INPUT 1N3613 16V SG1842 20kΩ 10<sub>p</sub>F = 820pF 20V T1: Coilcraft E - 4140 - b 0.01µF 1N3613 Primary - 97 turns $V_{FB}$ single AWG 24 $2.5k\Omega$ Secondary - 4 turns 150kΩ $27\Omega$ COMP 4 parallel AWG 22 OUT () Control - 9 turns 3.6kΩ ≥ 20kΩ ≥ 3 parallel AWG 28 100pF 1kO CUR >10kΩ SEN 470pF $\geq 0.85\Omega$ R<sub>T</sub>/C<sub>T</sub> GND 0.01µF **ISOLATION** BOUNDARY

FIGURE 25. — OFF-LINE FLYBACK REGULATOR

#### **SPECIFICATIONS**

 $V_{IN} = 90VAC:$ 

V<sub>IN</sub> = 130VAC:

Output short-circuit current:

Input line voltage: 90VAC to 130VAC Input frequency: 50 or 60Hz Switching frequency: 40KHz ±10% Output power: 25W maximum Output voltage: 5V +5% Output current: 2 to 5A Line regulation: 0.01%/V Load regulation: 8%/A\* Efficiency @ 25 Watts,

70%

65%

2.5Amp average

\* This circuit uses a low-cost feedback scheme in which the DC voltage developed from the primary-side control winding is sensed by the SG1842 error amplifier. Load regulation is therefore dependent on the coupling between secondary and control windings, and on transformer leakage inductance.





CURRENT MODE PWM CONTROLLER

THE INFINITE POWER OF INNOVATION PRODUCTION DATA SHEET

#### DESCRIPTION

The SG1844/45 family of control ICs provides all the necessary features to implement off-line fixed frequency, current-mode switching power supplies with a minimum number of external components. Current-mode architecture demonstrates improved line regulation, improved load regulation, pulse-bypulse current limiting and inherent protection of the power supply output switch.

The bandgap reference is trimmed to ±1% over temperature. Oscillator discharge current is trimmed to less than ±10%. The SG1844/45 has undervoltage lockout, current-limiting circuitry and start-up current of less than 1mA.

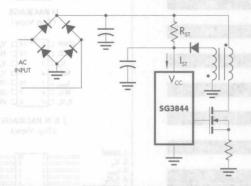
The totem-pole output is optimized to drive the gate of a power MOSFET. The output is low in the off state to provide direct interface to an N-channel device.

Both operate up to a maximum duty cycle range of zero to <50% due to an internal toggle flip-flop which blanks the output off every other clock cycle.

The SG1844/45 is specified for operation over the full military ambient temperature range of -55°C to 125°C. The SG2844/45 is specified for the industrial range of -25°C to 85°C, and the SG3844/45 is designed for the commercial range of 0°C to 70°C.

#### PRODUCT HIGHLIGHT

TYPICAL APPLICATION OF SG3844 IN A FLYBACK CONVERTER



#### KEY FEATURES

- OPTIMIZED FOR OFF-LINE CONTROL
- LOW START-UP CURRENT (<1mA)
- AUTOMATIC FEED FORWARD COMPENSATION
- TRIMMED OSCILLATOR DISCHARGE CURRENT
- PULSE-BY-PULSE CURRENT LIMITING
- ENHANCED LOAD RESPONSE CHARACTERISTICS
- UNDER-VOLTAGE LOCKOUT WITH 6V HYSTERESIS (SG1844 only)
- DOUBLE PULSE SUPPRESSION
- HIGH-CURRENT TOTEM-POLE OUTPUT
- INTERNALLY TRIMMED BANDGAP REFERENCE
- 500kHz OPERATION
- UNDERVOLTAGE LOCKOUT SG1844 - 16 volts SG1845 - 8.4 volts
- LOW SHOOT-THROUGH CURRENT <75mA OVER TEMPERATURE

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

			PACKAGE	ORDER II	NFORMAT	ION		
T <sub>A</sub> (°C)	M Ceramic DIP 8-pin	N Plastic DIP 14-pin	DM Plastic SOIC 8-pin	D Plastic SOIC 14-pin	Y Ceramic DIP 8-pin	J Ceramic DIP 14-pin	F Cer. Flatpack 10-pin	L Ceramic LCC 20-pin
0. 70	SG3844M	SG3844N	SG3844DM	SG3844D	SG3844Y	SG3844J		E. 132
0 to 70	SG3845M	SG3845N	SG3845DM	SG3845D	SG3845Y	SG3845J	peratu <del>-</del> Calcului	Ja <del>ss</del> len Te
05 - 05	SG2844M	SG2844N	SG2844DM	SG2844D	SG2844Y	SG2844J	tent are goodstass	nur 9 are
-25 to 85	SG2845M	SG2845N	SG2845DM	SG2845D	SG2845Y	SG2845J	_	_
-55 to 125		_	k 1 -	_	SG1844Y	SG1844J		SG1844L
-33 to 123			1-1-	-	SG1845Y	SG1845J	_	SG1845L
AAU CTD /002	D.N. 64	CT 2   1	-	_	SG1844Y/883B	SG1844J/883B	_	SG1844L/883B
MIL-STD/883	PACKAGE	<i>y</i> —	_		SG1845Y/883B	SG1845J/883B		SG1845L/883B
DECC		_		_	SG1844Y/DESC	SG1844J/DESC	SG1844F/DESC	SG1844L/DESC
DESC			_	_	SG1845Y/DESC	SG1845J/DESC	SG1845F/DESC	SG1845L/DESC

Note: All surface-mount packages are available in Tape & Reel.

terminal.

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#### CURRENT-MODE PWM CONTROLLER

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ABSOLUTE MAXIMUM RATINGS	(Notes 1 & 2)
Supply Voltage (I <sub>cc</sub> < 30mA)	Self Limiting
Supply Voltage (Low Impedance Source)	30V
Output Current (Peak)	±1A
Output Current (Continuous)	350mA
Output Energy (Capacitive Load)	5µJ
Analog Inputs (Pins 2, 3)	0.3V to +6.3V
Error Amp Output Sink Current	10mA
Operating Junction Temperature	
Hermetic (J, Y, F, L Packages)	150°C
Plastic (N, M, D, DM Packages)	150°C
Storage Temperature Range	65°C to +150°C
Lead Temperature (Soldering, 10 Seconds)	300°C
Note 1. Exceeding these ratings could cause damage to the Note 2. All voltages are with respect to Pin 5. All currents a	device.

#### THERMAL DATA

M PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	95°C/W
N PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	65°C/W
DM PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	165°C/W
D PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	120°C/W
Y PACKAGE:	The Paris
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	130°C/W
J PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	80°C/W
F PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO CASE, $\theta_{ m JC}$	80°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	145°C/W
L PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO CASE, $\theta_{_{JC}}$	35°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{ m JA}}$	120°C/W

The  $\theta_{IA}$  numbers are guidelines for the thermal performance of the device/pc-board

Junction Temperature Calculation:  $T_1 = T_A + (P_D \times \theta_{IA})$ .

system. All of the above assume no ambient airflow.

DM PACKAGE (Top View) COMP IT N.C. N.C. 11 W I<sub>SENSE</sub> III 10 DOUTPUT 9 I GND 8 PWR GND R,/C, D PACKAGE (Top View) COMP 13 N.C. N.C. 🗆 2 12 V<sub>c</sub>
11 V<sub>c</sub>
10 OUTPUT
9 GROUND N.C. 🗆 4 N.C. R,/C, 8 POWER GND J & N PACKAGE (Top View) 10.V<sub>REF</sub> 9. V<sub>CC</sub> 8. V<sub>C</sub> 2. V<sub>FB</sub>
3. I<sub>SENSE</sub>
4. R<sub>T</sub>/C<sub>T</sub> 7. OUTPUT 5. POWER GND 6. GND F PACKAGE (Top View) 3 2 1 20 19 11. N.C. 1. N.C. 12. PWR GND 2. N.C. 13. GND 3. COMP. 4. N.C. 14. N.C. 17 5. V<sub>F8</sub> 6. N.C. 15. OUTPUT 16 16. N.C. 15 7. I<sub>SENSE</sub> 8. R<sub>T</sub>/C<sub>T</sub> 17. V<sub>c</sub> 18. V<sub>cc</sub> 9. N.C. 19. N.C. 10. N.C. 20. V<sub>REF</sub> L PACKAGE

(Top View)

PACKAGE PIN OUTS

7 V<sub>cc</sub>
6 OUTP
5 GND

OUTPUT

7 V<sub>cc</sub>
6 OUTPUT 5 GND

COMP [

V<sub>FB</sub> = 2

M & Y PACKAGE (Top View) COMP I



#### CURRENT-MODE PWM CONTROLLER

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	Combal	Recommended Operating Conditions					
Parameter		Symbol	Min.	Min. Typ.		Units	
Supply Voltage Range				30	onses seuss	V	
Output Current (Peak)	E 28.8			±1	(8 % E asto	A	
Output Current (Continuous)	4.0		(2 = west)	200	I) Teubis Indul o	mA	
Analog Inputs (Pin 2, Pin 3)	0/	VdQ	0	(dastell) olites	2.6	V	
Error Amp Output Sink Current				5		mA	
Oscillator Frequency Range	DET 1		0.1		500	kHz	
Oscillator Timing Resistor		R <sub>T</sub>	0.52		150	kΩ	
Oscillator Timing Capacitor		C <sub>T</sub>	0.1		1.0	μF	
Operating Ambient Temperature Range:		240	109 - 100				
SG1844/45		AM	-55	1	125	°C	
SG2844/45	12.51	Amp	-25		85	°C	
SG3844/45 02 081 081	30	300 = .00	0		(70 OV)	°C	

#### ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for SG1844/SG1845 with -55°C  $\leq$  T $_A$   $\leq$  85°C, SG3844/SG3845 with 0°C  $\leq$  T $_A$   $\leq$  85°C, SG3844/SG3845 with 0°C  $\leq$  T $_A$   $\leq$  70°C, V $_{CC}$  = 15V (Note 7), R $_T$  = 10k $\Omega$ , and C $_T$  = 3.3nF. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	SC	51844 <i>i</i>	45	Se	2844	45	SC	Units		
raialletei	Syllioui	rest conditions	Min.	Тур.	Max.	Min.	Тур.	Max.	Min.	Тур.	Max.	Office
Reference Section												
Output Voltage		$T_{J} = 25^{\circ}C, I_{O} = 1 \text{mA}$	4.95	5.00	5.05	4.95	5.00	5.05	4.90	5.00	5.10	٧
Line Regulation	1 1	$12 \le V_{IN} \le 25V$		6	20		6	20	7.7	6	20	mV
Load Regulation	1 1 5	1 ≤ I <sub>o</sub> ≤ 20mA	1 = 100	6	25		6	25	HOTE	6	25	mV
Temperature Stability (Note 4)		34	AR	0.2	0.4		0.2	0.4		0.2	0.4	mV/°C
Total Output Variation (Note 4)		Line, Load, Temp.	4.90		5.10	4.90		5.10	4.82		5.18	V
Output Noise Voltage (Note 4)	V <sub>N</sub>	10Hz ≤ f ≤ 10kHz, T <sub>j</sub> = 25°C	A SELECT	50	100	PISETE	50	Stirite A	2207)1	50	1.1.0	μV
Long Term Stability (Note 4)	ali s <i>m</i> de,	T <sub>A</sub> = 125°C, 1000hrs	1	5	25	And herit	5	25	DE COLO	5	25	mV
Output Short Circuit	pa sercial bi	at uspen is	-30	-100	-180	-30	-100	-180	-30	-100	-180	mA
Oscillator Section	11-11						18 J.		Mar.			
Initial Accuracy (Note 8)		T <sub>J</sub> = 25°C	47	52	57	47	52	57	47	52	57	kHz
Voltage Stability		12V ≤ V <sub>CC</sub> ≤ 25V		.02	1	775 3	0.2	1	14.7	0.2	1	%
Temperature Stability (Note 4)		$T_{MIN} \le T_A \le T_{MAX}$		5			5			5		%
Amplitude		V <sub>RT/CT</sub> (Peak to Peak)		1.7			1.7			1.7		٧
Discharge Current		T <sub>J</sub> = 25°C	7.8	8.3	9.1	7.5	8.4	9.3	7.5	8.4	9.3	mA
		$T_{MIN} \le T_A \le T_{MAX}$	6.8		9.3	7.2		9.5	7.2		9.5	mA
Error Amp Section												ALC:
Input Voltage		$V_{COMP} = 2.5V$	2.45	2.50	2.55	2.45	2.50	2.55	2.42	2.50	2.58	٧
Input Bias Current				-0.3	-1		-0.3	1		-0.3	-2	μА
Open Loop Gain	A <sub>VOL</sub>	2 ≤ V <sub>O</sub> ≤ 4V	65	90		65	90		65	90		dB
Unity Gain Bandwidth (Note 4)		T <sub>J</sub> = 25°C	0.7	1		0.7	1		0.7	1		MHz
Power Supply Rejection Ratio	PSRR	12 ≤ V <sub>cc</sub> ≤ 25V	60	70		60	70		60	70		dB
Output Sink Current		$V_{VFB} = 2.7V, V_{COMP} = 1.1V$	2	6	19 7	2	6		2	6		mA
Output Source Current		$V_{VFB} = 2.3V$ , $V_{COMP} = 5V$	-0.5	-0.8		-0.5	-0.8		-0.5	-0.8		mA
V <sub>out</sub> High		$V_{VFB} = 2.3V$ , $R_L = 15K$ to gnd	5	6		5	6		5	6		٧
V <sub>OUT</sub> Low		$V_{VFR} = 2.7V, R_1 = 15K \text{ to } V_{RFF}$		0.7	1.1		0.7	1.1		0.7	1.1	٧

(Electrical Characteristics continue next page.)

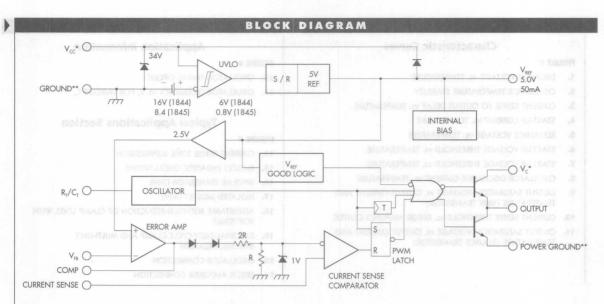


#### PRODUCTION DATA SHEET

					C		1		. disi	SC	1844	45	SG	2844/	45	SG	3844	45	Unit
	Param	eter			Symbo	mbol Test Conditions			Min.	Тур.	Max.	Min.	Тур.	Max.			Max.	Unit	
Current S	ense S	ection	1	no de	AE THE		-									1	ned to	estoy v	Serendi
Gain (Not	es 5 & 6	)		Fa .						2.85	3	3.15	2.85	3	3.15	2.85	3	3.15	V/V
Maximum I	nput Sig	nal (N	lote 5)	V10		V	COMP =	5٧		0.9	1	1.1	0.9	1	1.1	0.9	1	1.1	٧
Power Sup	ply Reje	ction F	Ratio (1	Note 5	) PSRR			c ≤ 25V			70			70	11	nia o	70	turnot s	dB
Input Bias	Current			2							-2	-10	7-7	-2	-10	5 dela	-2	-10	μΑ
Delay to O	utput (I	Note 4	)			7	0				150	300		150	300	089 V	150	300	ns
Output S	ection		77			93	0		9							Inhie	sit prin	off total	diard
Output Lo	w Level					1.	<sub>INK</sub> = 2	OmA	3		0.1	0.4		0.1	0.4	Tlosos	0.1	0.4	٧
								00mA			1.5	2.2	638	1.5	2.2	dms/	1.5	2.2	٧
Output His	th Level							20mA		13	13.5		13	13.5		13	13.5	MARK	٧
D-11	85							200m/	A	12	13.5		12	13.5		12	13.5	BAAM	٧
Rise Time (	Note 4)							5°C, C, =			50	150		50	150		50	150	ns
Fall Time (1							_	°C, C, =			50	150	to for	50	150	didw 1	50	150	ns
Under-Vo	-	ocko	ut Sec	tion				, _	3015										
Start Thres				T. THE		1	844	75.97	A TVE	15	16	17	15	16	17	14.5	16	17.5	٧
i sena si	and S. V					1 .0	845			7.8	8.4	9.0	7.8	8.4	9.0	7.8	8.4	9.0	V
Min. Opera	ation Vo	tage A	fter Tu	rn-On	D bns 3	-	844	17 100	1) 1/2/ = /	9	10	11	9	10	11	8.5	10	11.5	V
		3- 1			1,53	1	845	troide	n odi otilano	7.0	7.6	8.2	7.0	7.6	8.2	7.0	7.6	8.2	٧
PWM Sec	tion	1.50			STORY TO	1/11	G T			CS-1-50	39/1/2	WE ST	SET UN	0.33		W100	20.98	Thy file.	SACTO
Maximum [	40.00	le	-075							46	48	50	46	48	50	46	48	50	%
Minimum D				0.00	81111560	0 88	Q			40	40	0	40	40	0	40	40	0	%
Power Co			ection	200 3	20 11 2	0.5	707.3	20 h			*80 =	0			0		947,3396	ESSELV S	70
Start-Up Co		CIOII 3	CCCIOI	X I			Orași.	DATE.	20	1/20	0.5	1		0.5	1		0.5	1	mA
Operating		`urren	20	- A		V	- V	SENSE = 0	V	event to	11	17		11	17		11	17	mA
V <sub>cc</sub> Zener \		urren	8.0	9.0			$_{c} = 25$			21090	34	17		34	17	(2) Cal	34	17	V
TCC ZETTET T	Oltage	00.5	01-2	1913	00 5 5 0	10	c - 25	/III/\		- National Train	34			AV	All man	E84 - \$43	34	da nombre of	Series I
Notes: 4. Th			s, altho	ugh gu	iaranteed	l, are	e not	100% t€	ested in	6. 0	Gain de	efined	as: A =	ΔV	COMP ;	$0 \le V_{is}$	SENSE S	0.8V.	
	oduction		20			9	. 1			7. A	diust '	V abo	ve the	start	thresho	old bef	ore se	tting at	15V.
5. Pa	irameter	measu	red at 1	trip po	int of lat	ch v	vith V	$_{\rm VFB} = 0$ .										r frequ	
27 1																			
2 I																			
SP F																			
2 I																			
20 J 20 V Am 8.5 Am 2.5																			
# 1 # 2 Am 8.4 Am 2.5																			
# 1 # 2 Am 8.5 Am 8.5 Am 2.9 V 85.																			
P																			
P																			
P																			
20   1   2   2   2   2   2   2   2   2   2																			
02   1   1   1   1   1   1   1   1   1																			

#### CURRENT-MODE PWM CONTROLLER

#### PRODUCTION DATA SHEET



- \* V<sub>cc</sub> and V<sub>c</sub> are internally connected for 8-pin packages.
- \*\* POWER GROUND and GROUND are internally connected for 8-pin packages.



#### CURRENT-MODE PWM CONTROLLER

#### PRODUCTION DATA SHEET

#### **GRAPH / CURVE INDEX**

#### **Characteristic Curves**

#### FIGURE #

- 1. DROPOUT VOLTAGE vs. TEMPERATURE
- 2. OSCILLATOR TEMPERATURE STABILITY
- 3. CURRENT SENSE TO OUTPUT DELAY vs. TEMPERATURE
- 4. START-UP CURRENT vs. TEMPERATURE
- 5. REFERENCE VOLTAGE vs. TEMPERATURE
- 6. START-UP VOLTAGE THRESHOLD vs. TEMPERATURE
- 7. START-UP VOLTAGE THRESHOLD vs. TEMPERATURE
- 8. OSCILLATOR DISCHARGE CURRENT vs. TEMPERATURE
- OUTPUT SATURATION VOLTAGE vs. OUTPUT CURRENT AND TEMPERATURE (SINK TRANSISTOR)
- 10. CURRENT SENSE THRESHOLD vs. ERROR AMPLIFIER OUTPUT
- 11. OUTPUT SATURATION VOLTAGE vs. OUTPUT CURRENT AND TEMPERATURE (SOURCE TRANSISTOR)

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#### **Application Information**

#### FIGURE #

- 12. OSCILLATOR TIMING CIRCUIT
- 13. OSCILLATOR FREQUENCY vs. R, FOR VARIOUS C,

#### **Typical Applications Section**

#### FIGURE #

- 14. CURRENT SENSE SPIKE SUPPRESSION
- 15. MOSFET PARASITIC OSCILLATIONS
- 16. BIPOLAR TRANSISTOR DRIVE
- 17. ISOLATED MOSFET DRIVE
- ADJUSTABLE BUFFERED REDUCTION OF CLAMP LEVEL WITH SOFTSTART
- 19. EXTERNAL DUTY CYCLE CLAMP AND MULTI-UNIT SYNCHRONIZATION
- 20. OSCILLATOR CONNECTION
- 21. ERROR AMPLIFIER CONNECTION



#### CURRENT-MODE PWM CONTROLLER

#### PRODUCTION DATA SHEET

FIGURE 1. — DROPOUT VOLTAGE VS. TEMPERATURE

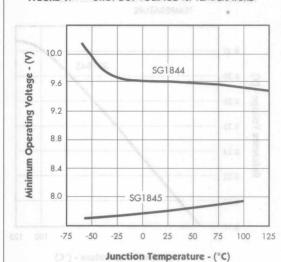


FIGURE 2. — OSCILLATOR TEMPERATURE STABILITY

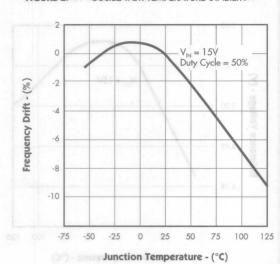


FIGURE 3. — CURRENT SENSE TO OUTPUT DELAY vs.

TEMPERATURE

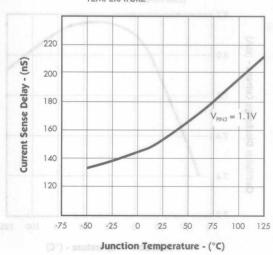


FIGURE 4. — START-UP CURRENT VS. TEMPERATURE

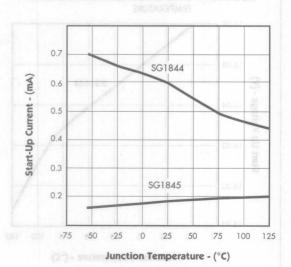


FIGURE 5. — REFERENCE VOLTAGE vs. TEMPERATURE

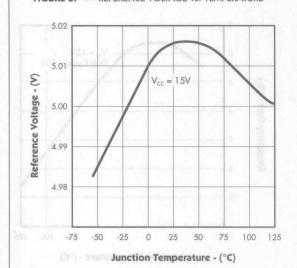


FIGURE 6. — START-UP VOLTAGE THRESHOLD Vs.

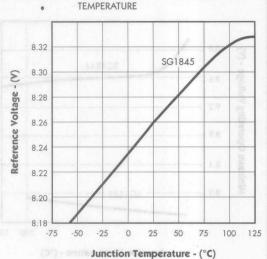


FIGURE 7. — START-UP VOLTAGE THRESHOLD vs. **TEMPERATURE** 

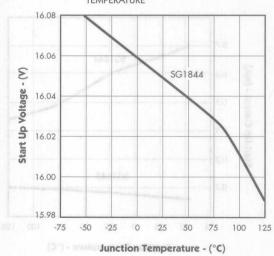
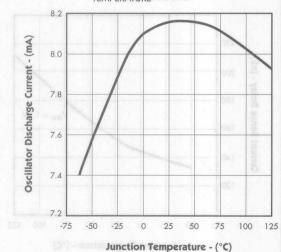


FIGURE 8. — OSCILLATOR DISCHARGE CURRENT vs. TEMPERATURE



## CURRENT-MODE PWM CONTROLLER

#### PRODUCTION DATA SHEET

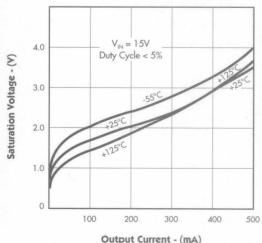
#### CHARACTERISTIC CURVES

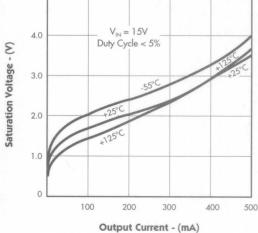
FIGURE 9. — OUTPUT SATURATION VOLTAGE vs. **OUTPUT CURRENT & TEMPERATURE** 2.0 3 Saturation Voltage 1.0  $V_{IN} = 15V$ Duty Cycle < 5% 0.5 200 400 Output Current - (mA)

FIGURE 10. — CURRENT SENSE THRESHOLD vs. ERROR AMPLIFIER OUTPUT 1.0 0.9 Current Sense Threshold - (V) 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1 3.0 1.0

Error Amp Output Voltage - (V)

FIGURE 11. — OUTPUT SATURATION VOLTAGE vs. **OUTPUT CURRENT & TEMPERATURE** 





#### CURRENT-MODE PWM CONTROLLER

#### PRODUCTION DATA SHEET

#### APPLICATION INFORMATION

#### **OSCILLATOR**

The oscillator of the 1844/45 family of PWM's is programmed by the external timing components (RT, CT) as shown in Figure 13.

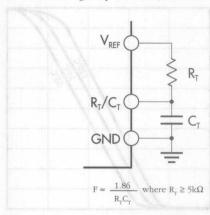


FIGURE 12 — OSCILLATOR TIMING CIRCUIT

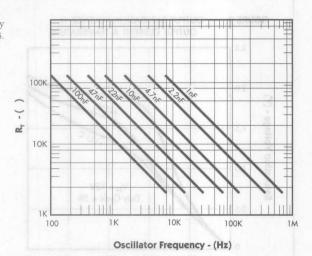
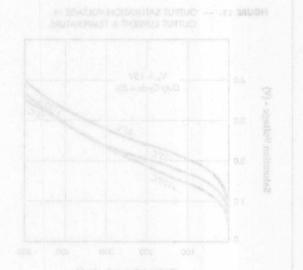


FIGURE 13 — OSCILLATOR FREQUENCY vs. R, FOR VARIOUS C,



#### CURRENT-MODE PWM CONTROLLER

#### PRODUCTION DATA SHEET

#### TYPICAL APPLICATION CIRCUITS

Pin numbers referenced are for 8-pin package and pin numbers in parenthesis are for 14-pin package.

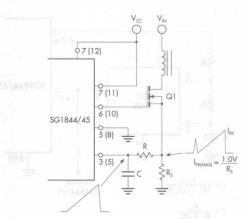


FIGURE 14. — CURRENT SENSE SPIKE SUPPRESSION

The RC low-pass filter will eliminate the leading edge current spike caused by parasitics of Power MOSFET.

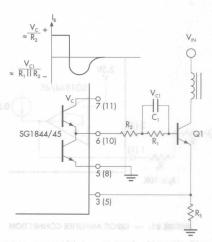


FIGURE 16. — BIPOLAR TRANSISTOR DRIVE

The 1844/45 output stage can provide negative base current to remove base charge of power transistor  $(Q_j)$  for faster turn off. This is accomplished by adding a capacitor  $(C_i)$  in parallel with a resistor  $(R_i)$ . The resistor  $(R_i)$  is to limit the base current during turn on.

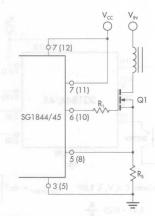


FIGURE 15. — MOSFET PARASITIC OSCILLATIONS

A resistor  $(R_i)$  in series with the MOSFET gate reduce overshoot and ringing caused by the MOSFET input capacitance and any inductance in series with the gate drive. (Note: It is very important to have a low inductance ground path to insure correct operation of the I.C. This can be done by making the ground paths as short and as wide as possible.)

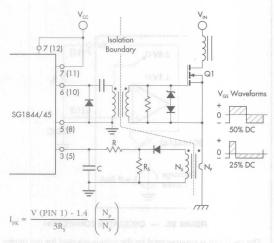


FIGURE 17. — ISOLATED MOSFET DRIVE

Current transformers can be used where isolation is required between PWM and Primary ground. A drive transformer is then necessary to interface the PWM output with the MOSFET.

#### TYPICAL APPLICATION CIRCUITS (continued)

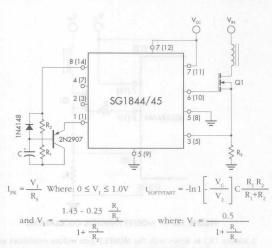


FIGURE 18. — ADJUSTABLE BUFFERED REDUCTION OF CLAMP LEVEL WITH SOFTSTART

Softstart and adjustable peak current can be done with the external circuitry shown above.

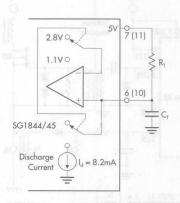
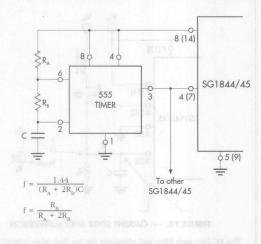


FIGURE 20. — OSCILLATOR CONNECTION

The oscillator is programmed by the values selected for the timing components  $R_{\rm T}$  and  $C_{\rm T}$ . Refer to application information for calculation of the component values.



## FIGURE 19. — EXTERNAL DUTY CYCLE CLAMP AND MULTI-UNIT SYNCHRONIZATION

Precision duty cycle limiting for a duty cycle of <50%, as well as synchronizing several 1844/45's is possible with the above circuitry.

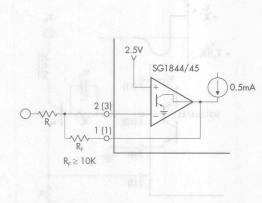


FIGURE 21. — ERROR AMPLIFIER CONNECTION

Error amplifier is capable of sourcing and sinking current up to 0.5mA.



## SG1846/SG2846/SG3846

#### CURRENT MODE PWM CONTROLLER

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

The SG1846 family of control ICs provides all of the necessary features to implement fixed frequency, current mode control schemes while maintaining a minimum external parts count. The superior performance of this technique can be measured in improved line regulation, enhanced load response characteristics, and a simpler, easier-to-design control loop. Topological advantages include inherent pulse-by-pulse current limiting capability, automatic symmetry correction for push-pull converters, and the ability to

parallel "power modules" while maintaining equal current sharing.

Protection circuitry includes built-in under-voltage lockout and programmable current limit in addition to soft start capability. A shutdown function is also available which can initiate either a complete shutdown with automatic restart or latch the supply off.

Other features include fully latched operation, double pulse suppression, deadtime adjust capability, and a ±1% trimmed bandgap reference.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### **KEY FEATURES**

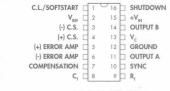
- AUTO-FEED FORWARD COMPENSATION
- PROGRAMMABLE PULSE BY PULSE CURRENT LIMITING
- AUTOMATIC SYMMETRY CORRECTION IN PUSH-PULL CONFIGURATION
- PUSH-PULL CONFIGURATION

  ENHANCED LOAD RESPONSE CHARACTERISTICS
- PARALLEL OPERATION CAPABILITY FOR MODULAR POWER SYSTEMS
- DIFFERENTIAL CURRENT SENSE AMPLIFIER WITH WIDE COMMON MODE RANGE
- DOUBLE PULSE SUPPRESSION
- 200mA TOTEM-POLE OUTPUTS
- ±1% BANDGAP REFERENCE
- UNDER-VOLTAGE LOCKOUT
- SOFT-START & SHUTDOWN CAPABILITY
- 500kHz OPERATION

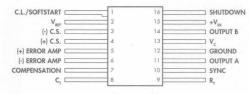
#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

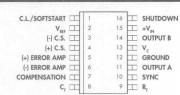
#### PACKAGE PIN OUTS



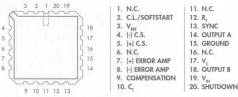
#### J & N PACKAGE (Top View)



F PACKAGE (Top View)



DW PACKAGE (Top View)



#### L PACKAGE (Top View)

PACKAGE ORDER INFORMATION								
T <sub>A</sub> (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	DW Plastic SOWB 16-pin	F Ceramic Flat Pack 16-pin	L Ceramic LCC 20-pin			
0 to 70	SG3846N	SG3846J	SG3846DW	_				
-25 to 85	SG2846N	SG2846J	SG2846DW	<del>-</del>	_			
-55 to 125	_	SG1846J		- T	SG1846L			
MIL-STD-883	_	SG1846J/883B	_		SG1846L/883B			
DESC	-	SG1846J/DESC		SG1846F/DESC	SG1846L/DESC			

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3846DWT)

## Notes



## SG29055/SG29055A

LOW DROPOUT DUAL REGULATOR

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

The SG29055/SG29055A is a dual 5V/ 5V positive voltage regulator. One output is a high current (up to 1000mA) regulator that can be turned on or off by a high impedance low current TTL compatible switch. The second or standby output remains on regardless. The on/off switch not only shuts off the high current output, but actually puts the IC in a micropower mode making possible a low quiescent current. This unique characteristic coupled with an extremely low dropout, (0.55V for output current of 10mA) makes the SG29055/SG29055A well suited for power systems that require standby memory. The SG29055/SG29055A includes other features which were originally designed for automotive applications. These include protection from reverse battery installations and

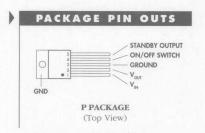
double battery jumps. The high current regulator has overvoltage shutdown to protect both the internal circuitry and the load during line transients, such as load dump (60V). In addition, the high current regulator design also has built-in protection for short circuit and thermal overload. During these fault conditions of the primary regulator the standby regulator will continue to power its load.

The SG29055 is the 5 volt, ±5% version of a family of dual regulators with a standby output voltage of 5V. Other high current outputs of 8.2V and 12V are available. Also available is the SG29055A which offers an improved output voltage tolerance of ±2%. They are available in the plastic TO-220 power package and are designed to function over the automotive ambient temperature range of -40° to 85°C.

#### KEY FEATURES

- 2% INTERNALLY TRIMMED OUTPUT
- TWO REGULATED OUTPUTS
- OUTPUT CURRENT IN EXCESS OF 1000mA
- LOW QUIESCENT CURRENT STANDBY REGULATOR
- INPUT-OUTPUT DIFFERENTIAL LESS THAN 0.6V AT 0.5A
- REVERSE BATTERY PROTECTION
- 60V LOAD DUMP PROTECTION
- -50V REVERSE TRANSIENT PROTECTION
- SHORT CIRCUIT PROTECTION
- INTERNAL THERMAL OVERLOAD PROTECTION
- ON/OFF SWITCH FOR HIGH CURRENT

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK



# PACKAGE ORDER INFO T<sub>A</sub> (°C) P Plastic TO-220 5-pin -45 to 85 SG29055P SG29055AP

### Notes

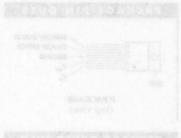
PRODUCTION DATA SHEET

- TUTTUO GENERALLY TRANSPORT VIEW
  - IN TWO REGULATED OUTFUTS
- IL CHIPUT CHRENT IN EXCESS OF 1000m
- IN TOW CITESCENT COMEND STANDBA
- MAH 220 IATHEBRIO TUTTO TUNG &
  - ACATO TROVIN VICTOR OF TRANSPORT AND
  - NUMBER SETTING SETTING
- MANUAL COMPANION OF THE STATE O
- MONTO TORONT TROPECTION
  - MINISTRAL INSTRACT OVER CAD
  - TRUBBLE HOW BOTH STORE DESIGN
  - IN CHICK SWITCH FOR HIGH CURBING

doolsie bastery jamps. The high coment regulation has overvoinge shatshown to regulation has been incruity and the first bine business spin as lead dump (60%). In addition, the high current regulator design that has built in protection for that curvit and themal current could be for the standard of the princey regulator for attaches

The SC28055/SC29055A is a deal 5V positive voltage regulator. One cupulate is a high current (up to 1000mA) by a high impedence low current [78] by a high impedence low current [78] computates as with The second or standby outsign market on regulalises. The carolf switch and only share on regulalises, high current output, but securilly passible a low quiestent current. This possible a low quiestent current. This cartenady low dropout, (0.53V for output current of 10mA) makes the output current of 10mA) makes the power systems (that require search) makes the memory. The SC29055 SC29055A cut and for memory. The SC29055 SC29055A cut includes other features which were includes other features which were applications. These include protection applications. These include protections.

CONNECTE SPECIFICATIONS AVAILABLE FROM "LIM" FAX SYSTEM SEE PARK 4-1) AND 1990/91 SEECCH GENERAL DASASOR



T<sub>1</sub> (°C) - TO Plant TO-220 T<sub>2</sub> (°C) - TO Plant TO-220 Solves Solves





### SG29085/SG29085A

LOW DROPOUT DUAL REGULATOR

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

### DESCRIPTION

The SG29085/SG29085A is a dual 8.2V/ 5V positive voltage regulator. One output is a high current (up to 1000mA) regulator that can be turned on or off by a high impedance low current TTL compatible switch. The second or standby output remains on regardless. The on/off switch not only shuts off the high current output but actually puts the IC in a micropower mode making possible a low quiescent current. This unique characteristic coupled with an extremely low dropout, (0.55V for output current of 10mA) makes the SG29085/SG29085A well suited for power systems that require standby memory. The SG29085/SG29085A includes other features which were originally designed for automotive applications. These include protection from reverse battery installations and

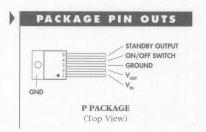
double battery jumps. The high current regulator has overvoltage shutdown to protect both the internal circuitry and the load during line transients, such as load dump (60V). In addition, the high current regulator design also has built-in protection for short circuit and thermal overload. During these fault conditions of the primary regulator the standby regulator will continue to power its load.

The SG29085 is the 8.2 volt, ±5% version of a family of dual regulators with a standby output voltage of 5V. Other high current outputs of 5 and 12 volts are available. Also available is the SG28085A which offers an improved output voltage tolerance of ±2%. They are available in the plastic TO-220 power package and are designed to function over the automotive ambient temperature range of -40° to 85°C.

### **KEY FEATURES**

- 2% INTERNALLY TRIMMED OUTPUT
- TWO REGULATED OUTPUTS
- OUTPUT CURRENT IN EXCESS OF 1000mA
- LOW QUIESCENT CURRENT STANDBY REGULATOR
- INPUT-OUTPUT DIFFERENTIAL LESS THAN 0.6V AT 0.5A
- REVERSE BATTERY PROTECTION
- 60V LOAD DUMP PROTECTION
- -50V REVERSE TRANSIENT PROTECTION
- SHORT CIRCUIT PROTECTION
- INTERNAL THERMAL OVERLOAD PROTECTION
- ON/OFF SWITCH FOR HIGH CURRENT OUTPUT

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK



## PACKAGE ORDER INFO T<sub>A</sub> (°C) P Plastic TO-220 5-pin SG29085P SG29085AP

### **Notes**

PRODUCTION DATA SHEET

THE INSTRUCT POWER OF INTOVITOR

- E SE INTEREVELY FRAMMED COTFOLI FOR THE CLOSENT IN EXCESS OF TROBING LOW CLUESCENT CLUED IT STANDEY
- INNUT-OUTFUT DIFFERENTIAL LESS THEAM
  - M REVEREE BATTERY PROTECTION
- MORDERON VALUE ORGANISM ON THE
- E SHOT CIRCUIT PROTECTION
  - B INTERNAL THERWAL OVERLOAD
  - PROTECTION

    ONPOSE SWITCH FOR HIGH CURRENT

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Other high current outputs of 5 and 12 works are available. Also available is the SC 25055A which offers an improved output voluge (oferance of ±2%. They are available in the places TO-220 power package and are designed to function over the attentions for anthrest

The SG2905-S-SG29085A is a dual 8-2V 5V positive voltage regulator. One regulator that can be turned on to 1000th A 5V a fight hispedance low content TIL by a high hispedance low content TIL compatible switch. The second or standby output remains on regardless, standby output remains on regardless. The on-off switch not only shuts off the high current output but actually puts the IC in a micropower mode making possible a low quiescent current. This extremely low dropout (0.55V for extremely low dropout, (0.55V for power systems 10000). The SG29085-SG25085A mixed includes other features which were includes other features which were originally designed for automother originally designed for automother.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIM!" FAX SYSTEM (SEE PAGE 4-1), AND "1 990/91 SILICON GENERAL DATABOON







### SG29125/SG29125A

### LOW DROPOUT DUAL REGULATOR

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

### DESCRIPTION

The SG29125/SG29125A is a dual 12V/ 5V positive voltage regulator. One output is a high current (up to 1000mA) regulator that can be turned on or off by a high impedance low current TTL compatible switch. The second or standby output remains on regardless. The on/off switch not only shuts off the high current output but actually puts the IC in a micropower mode making possible a low quiescent current. This unique characteristic coupled with an extremely low dropout, (0.55V for output current of 10mA) makes the SG29125/SG29125A well suited for power systems that require standby memory. The SG29125/SG29125A includes other features which were originally designed for automotive applications. These include protection from reverse battery installations and

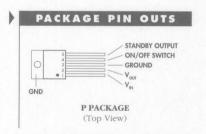
double battery jumps. The high current regulator has overvoltage shutdown to protect both the internal circuitry and the load during line transients, such as load dump (60V). In addition, the high current regulator design also has built-in protection for short circuit and thermal overload. During these fault conditions of the primary regulator the standby regulator will continue to power its load.

The SG29125 is the 12 volt, ±5% version of a family of dual regulators with a standby output voltage of 5V. Other high current outputs of 5 and 8.2 volts are available. Also available is the SG29125A which offers an improved output voltage tolerance of ±2%. They are available in the Plastic TO-220 power package and are designed to function over the automotive ambient temperature range of -40° to 85°C.

### KEY FEATURES

- 2% INTERNALLY TRIMMED OUTPUT
- TWO REGULATED OUTPUTS
- OUTPUT CURRENT IN EXCESS OF 1000mA
- LOW QUIESCENT CURRENT STANDBY REGULATOR
- INPUT-OUTPUT DIFFERENTIAL LESS THAN 0.6V AT 0.5A
- REVERSE BATTERY PROTECTION
- 60V LOAD DUMP PROTECTION
- -50V REVERSE TRANSIENT PROTECTION
- SHORT CIRCUIT PROTECTION
- INTERNAL THERMAL OVERLOAD PROTECTION
- ON/OFF SWITCH FOR HIGH CURRENT OUTPUT

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK



## PACKAGE ORDER INFO T<sub>A</sub> (°C) P Plastic TO-220 5-pin SG29125P SG29125AP

- TUSTON STEER AND THANKED OUTSUT
- SUPPLY CURRENT IN EXCESS OF 1000mA
- SOW GUILSCENT CURRENT STANDEY
  REGULATOR
- M INPUT-OUTPUT DISTRIBUTIAL (ESS TEAM)
  - MOST SERVICE WATERWAY THOM
  - MONTO DUNE PROCECTION
- NOTE THE PROPERTY OF THE PROPERTY OF
  - W SHORT CIRCUIT RIGHTSCTICAN
    - SELF TRANSPORTER
- M ON OIL SWITCH FOR HIGH CORRENT

double lantiere intuits. His high current maintaire has overvishing shouldown to percent both the mangal current, such as fored during for?) In addition, the high local during (60%). In addition, the high current resultator dissign also has build protection for storal operation of the protein of overload. Thering these has conditional of the primary regulator the transity regulator will continue to power its form

sension of a facility of doub respirators with a maidley origen voltage of 5 V. Wither high current outputs of 5 tool 8.2 Voltage are evaluated. Also available is the output college without others an improved output college of x2%. They are evaluated in Parameters of x2%. They prover parinage and are designed to prover parinage and are designed to distribute outputs authority outputs.

The SG20125 SG20125A is a deal 13V goodfee volcage regulator. One output is a high current (up to 1006mth regulator that can be amed on at all layers and the layer of the second or an amount of the second or an amount of the second or the output sent in the second or thing, current output but actually puts the IC in a micropower mode making puts like IC in a micropower mode making puts like IC in a micropower mode making puts and the IC in a micropower mode oraking goodslike in low current current of think makes the output current of 10mk makes the power system that require suited for micropy. The SG29125 NG29135A micropy of the sign of for automotive originally design of for automotive applications. These neclude protocolors

COMPLETE SPECIFICATIONS AVAILABLE FLOW "LIN" FAX SYSTEM (SEE PROSENT) AND 1990/91 SHOOM GENERAL DATABOOK





### 5V Undervoltage Sensing Circuit

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

### DESCRIPTION

The SG33164 and the SG34164 are micropower undervoltage sensing circuits ideal for use in low-power battery applications, computer peripheral, consumer, appliance and automotive equipment. The device offers a 1.2V temperature compensated bandgap reference, a precision comparator with hysteresis and a high

current open collector output. This device operates from 1 to 10V input supply and drains <10µA in the non-fault condition and trip level of 4.33V.

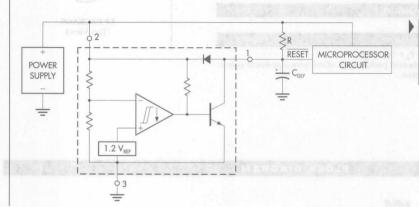
Both devices are available in an 8-pin, 150mil SOIC package and a plastic TO-92 package. The SG33164 is rated from -40°C to 85°C and the SG34164 from 0°C to 70°C.

### KEY FEATURES

- LOW STANDBY CURRENT
- TEMPERATURE COMPENSATED BANDGAP REFERENCE
- PRECISION COMPARATOR WITH 50MV OF HYSTERESIS
- CLAMP DIODE FOR DISCHARGING DELAY CAPACITOR
- OUTPUT CURRENT SINK CAPABILITY FROM 7 TO 50MA
- 1-10V INPUT SUPPLY RANGE
- AVAILABLE IN 150MIL, 8-PIN SOIC AND PLASTIC TO-92 PACKAGES
- PIN-FOR-PIN COMPATIBLE WITH MC33164/ 34164

### PRODUCT HIGHLIGHT

LOW-VOLTAGE MICROPROCESSOR RESET



### APPLICATIONS

- µPOWER RESET GENERATOR
- 5V VOLTAGE MONITOR
- BATTERY-LEVEL DETECTOR

### PACKAGE ORDER INFORMATION

T <sub>A</sub> (°C)	DM Plastic SOIC 8-pin	LP Plastic TO-92 3-pin
0 to 70	SG34164DM	SG34164LP
-40 to 85	SG33164DM	SG33164LP

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG34164DMT)

### 5V Undervoltage Sensing Circuit

### TREATA THO TEN PRODUCTION DATA SHEET

### ABSOLUTE MAXIMUM RATINGS (Note 1)

Input Supply Voltage (V <sub>IN</sub> )	-1V to 12V
	-1V to 12V
Operating Junction Temperature	had condition and trip level of &
Plastic (DM - Package)	150°C
Storage Temperature Range	65°C to 150°C
Lead Temperature (Soldering, 10 seconds)	300°C

Note 1. Values beyond which damage may occur. All voltages are specified with respect to ground, and all currents are positive into the specified terminal.

### THERMAL DATA

### DM PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT,  $\theta_{j_A}$  165°C/W

THERMAL RESISTANCE-JUNCTION TO AMBIENT,  $\theta_{_{JA}}$ 

Junction Temperature Calculation:  $T_J = T_A + (P_D \times \theta_{JA})$ . The  $\theta_{JA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

### PACKAGE PIN OUTS

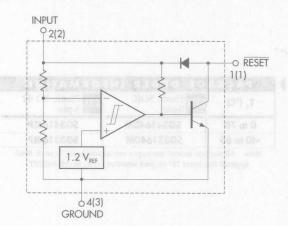
RESET		1	8	N.C.
INPUT		2	7	N.C.
N.C.	00	3	6	N.C.
GROUND		4	5	N.C.

DM PACKAGE (Top View)



LP PACKAGE (Top View)

### BLOCK DIAGRAM





### 5V UNDERVOLTAGE SENSING CIRCUIT

### PRODUCTION DATA SHEET

RECOMMENDED OPERATING CONDITIONS (Note 2)							
Parameter	Symbol	Recommended Operating Co			Units		
raidiletei	Syllidol	Min.	Тур.	Max.	Units		
Input Supply Voltage		across 1 west or	SHOULD VOLLAGE	10	V		
RESET Output Voltage		22747	Mar Til House our Size at	10	V		
Clamp Diode Forward Current		Per consequence	Avenue a service and	50	mA		
Operating Ambient Temperature Range:		FREDGIO.	3 31100 EV 1204 E-016	TOTAL TOTAL SECTION	14		
SG34164	TA	0	SUATION TORK	70	°C		
SG33164	TA	-40	(HDH of WO.)	85	°C		

### **ELECTRICAL CHARACTERISTICS**

(Unless otherwise specified, these specifications apply over the operating ambient temperatures of  $0^{\circ}\text{C} \le T_{A} \le 70^{\circ}\text{C}$  for the SG34164 and  $-40^{\circ}\text{C} \le T_{A} \le 85^{\circ}\text{C}$  for the SG33164. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Note 2. Range over which the device is guaranteed functional.

Parameter	Symbol	Test Conditions	SG33	164 / SG	34164	Units
Farameter	Symoon	Test conditions		Тур.	Max.	Unit
Total Device						
Operating Input Voltage Range	V <sub>IN</sub>		1.0		10	٧
Quiescent Input Current	I <sub>IN</sub>	V <sub>IN</sub> = 5.0V		10	20	μΑ
		$V_{IN} = 10V$		19	50	μА
Comparator Section						
Threshold Voltage					100	
High-State Output	V <sub>IH</sub>	V <sub>IN</sub> Increasing	4.15	4.33	4.45	٧
Low-State Output	V <sub>IL</sub>	V <sub>IN</sub> Decreasing	4.15	4.27	4.45	٧
Hysteresis	V <sub>H</sub>		0.02	0.06		٧
RESET Output Section						
Output Sink Saturation	V <sub>OL</sub>	$V_{IN} = 4.0V, I_{SINK} = 1.0mA$		0.05	0.40	V
		$V_{IN} = 1.0V, I_{SINK} = 0.25mA$		0.06	0.30	٧
Output Sink Current	I <sub>SINK</sub>	V <sub>IN</sub> , RESET = 4.0V	7.0		50	mA
Output Off-State Leakage		$V_{IN}$ , $\overline{RESET} = 5.0V$			0.5	μA
		V <sub>IN</sub> , RESET = 10V			2.0	μA
Clamp Diode Forward Voltage	V <sub>e</sub>	Pin 1 to pin 2, $(I_s = 5.0 \text{mA})$	0.6		1.2	V

### 5V UNDERVOLTAGE SENSING CIRCUIT

### PRODUCTION DATA SHEET

### **GRAPH / CURVE INDEX**

### **Characteristic Curves**

### FIGURE #

- 1. COMPARATOR THRESHOLD VOLTAGE vs. TEMPERATURE
- 2. RESET OUTPUT VOLTAGE vs. INPUT VOLTAGE
- 3. RESET OUTPUT SATURATION vs. SINK CURRENT
- 4. INPUT CURRENT vs. INPUT VOLTAGE
- 5. RESET DELAY TIME (LOW to HIGH)
- 6. RESET DELAY TIME (HIGH to LOW)

### FIGURE INDEX

### **Application Circuits**

### FIGURE #

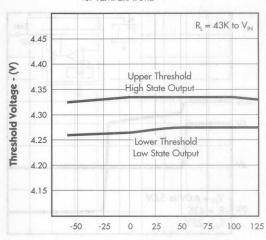
- SWITCHING THE LOAD OFF WHEN BATTERY REACHES BELOW 4.3V
- 8. LOW VOLTAGE MICROPROCESSOR RESET
- 9. VOLTAGE MONITOR
- 10. MOSFET LOW VOLTAGE GATE DRIVE PROTECTION

### 5V Undervoltage Sensing Circuit

PRODUCTION DATA SHEET

### CHARACTERISTIC CURVES

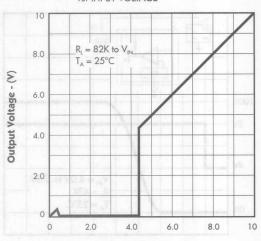
FIGURE 1. — COMPARATOR THRESHOLD VOLTAGE vs. TEMPERATURE



Junction Temperature - (°C)

FIGURE 2. — RESET OUTPUT VOLTAGE

VS. INPUT VOLTAGE



Input Voltage - (V)

FIGURE 3. — RESET OUTPUT SATURATION vs. SINK CURRENT

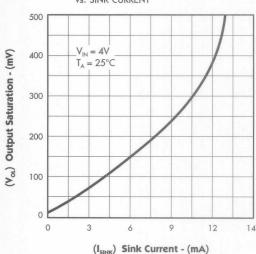
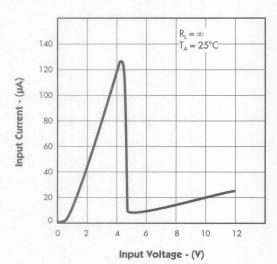


FIGURE 4. — INPUT CURRENT vs. INPUT VOLTAGE



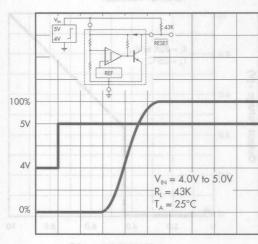
**LINFINITY** 

### 5 V Undervoltage Sensing Circuit

### PRODUCTION DATA SHEET

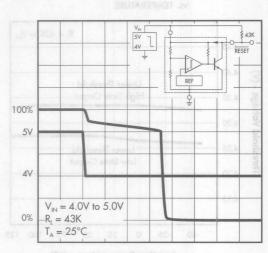
### CHARACTERISTIC CURVES

FIGURE 5. — RESET DELAY TIME (LOW TO HIGH)

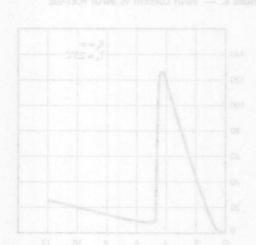


2µs/DIV.

### FIGURE 6. — RESET DELAY TIME (HIGH TO LOW)



0.5µs/DIV.

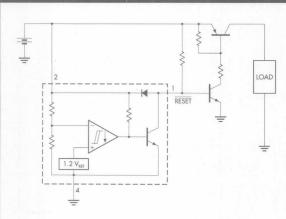


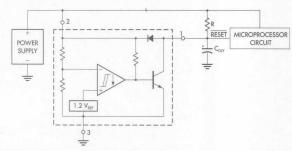
300 V<sub>ss</sub> = 4V 300 T<sub>s</sub> = 25°C 200 C

### 5V UNDERVOLTAGE SENSING CIRCUIT

### PRODUCTION DATA SHEET

### TYPICAL APPLICATION CIRCUITS





A time delayed reset can be accomplished with the addition of  $C_{\rm DLY}$ . For systems with extremely fast power supply rise times (< 500ns) it is recommended that the RC $_{\rm DLY}$  time constant be greater than 5.0 $\mu$ s.  $V_{\rm THOMPO}$  is the microprocessor reset input threshold.

$$t_{\text{DLY}} = R C_{\text{DLY}} \ln \left[ \frac{1}{1 - \frac{V_{\text{TH[MPU]}}}{V_{\text{IN}}}} \right]$$

FIGURE 7. — SWITCHING THE LOAD OFF WHEN BATTERY VOLTAGE REACHES BELOW 4.3V



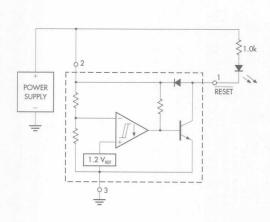
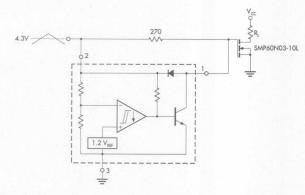


FIGURE 9. — VOLTAGE MONITOR



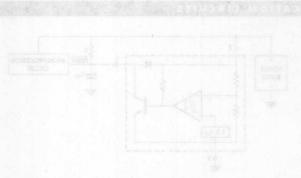
Overheating of the logic level power MOSFET due to insufficient gate voltage can be prevented with the above circuit. When the input signal is below the 4.3 volt threshold of the SG34164, its output grounds the gate of the L<sup>2</sup> MOSFET.

FIGURE 10. — MOSFET LOW-VOLTAGE GATE DRIVE PROTECTION



### Notes

### PRODUCTION DATA SHEET



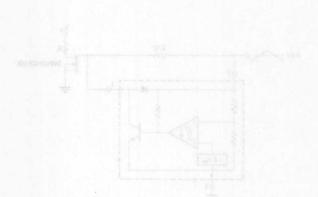
A horse delayed used can be accomplished with the addition of C<sub>1,12</sub>.

This contents with entremely that power supply rise times (< \$200mt) it recommended that the RC<sub>1,12</sub> dim constant be greater than 5 dim.

V. is the manufacturenesses used throw threshold.

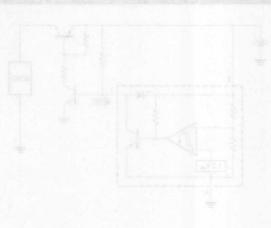
$$I_{tot} = R C_{tot} \ln \left[ \frac{1}{1 - V_{total}} \right]$$

RESERVE SO - LOWARDLINGS MICROPROCESSOR RESERV



New mealing of the logic level grower MINFET due to insufficient the past welfage are to presented with the showe official. When the past welfage are the first the state of the SUS-104, its autom grownds the gave or the L<sup>\*</sup> MINFET.

NUMBER VO. - MOSPET LOW-VOLTAGE GATE DRIVE PROTECTION



NGURE 7. — SWICHING THE LOAD OF WHEN BATTERY VOLTAGE REACHES BELCW & BY

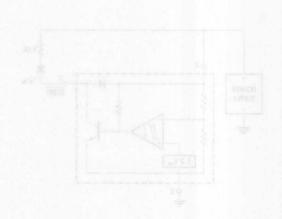


FIGURE 9. -- VOLVICE MONTHON







### 3.3V Undervoltage Sensing Circuit

THE INFINITE POWER OF INNOVATIONAL PRODUCTION DATA SHEET

### DESCRIPTION

The SG3546 is an undervoltage sensing circuit specifically designed for use as a reset controller in 3.3V microprocessor-based applications. Its micropower operation makes this device ideal for portable applications where extended battery life is required. The device offers a 1.2V temperature compensated bandgap reference, a

precision comparator with hysteresis and a high-current open collector output. This device operates from 1 to 10V input supply and drains <10µA in the non-fault condition.

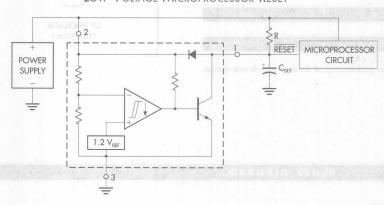
The SG3546 is available in an 8-pin 150mil SOIC package or a 3-pin TO-92 package and is rated for an ambient temperature of 0°C to 70°C.

### KEY FEATURES

- LOW STANDBY CURRENT
- INTERNAL VOLTAGE THRESHOLD AT 2.95V
- TEMPERATURE COMPENSATED BANDGAP REFERENCE
- PRECISION COMPARATOR WITH 40MV OF **HYSTERESIS**
- CLAMP DIODE FOR DISCHARGING DELAY CAPACITOR
- OUTPUT CURRENT SINK CAPABILITY (typ 5mA)
- 1-10V INPUT SUPPLY RANGE
- AVAILABLE IN 150MIL, 8-PIN SOIC AND 3-PIN TO-92 PACKAGES

### PRODUCT HIGHLIGHT

LOW-VOLTAGE MICROPROCESSOR RESET



### ORDER INFORMATION Plastic TO-92 TA (°C)

8-nin 3-pin 0 to 70 SG3546DM **SG3546LP** Note: All surface-mount packages are available in Tape & Reel.

Append the letter "T" to part number. (i.e. SG3546DMT)

FOR FURTHER INFORMATION CALL (714) 898-8121

### SG3546

### 3.3V Undervoltage Sensing Circuit

### TARRE ATAG BOT PRODUCTION DATA SHEET

ABSOLUTE MAXIMUM RATIN	IGS (Note 1)
Input Supply Voltage (V <sub>IN</sub> )	1V to 12V
RESET Output Voltage (V <sub>OUT</sub> )	
	100mA
Operating Junction Temperature	
Plastic (DM - Package)	150°C
Storage Temperature Range	65°C to 150°C
Lead Temperature (Soldering, 10 seconds)	300°C

Note 1. Values beyond which damage may occur. All voltages are specified with respect to ground, and all currents are positive into the specified terminal.

### THERMAL DATA

### DM PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT,  $\theta_{\rm JA}$  165°C/W

LP PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT,  $\theta_{\rm JA}$  156°C/W

Junction Temperature Calculation:  $T_J = T_A + (P_D \times \theta_{JA})$ . The  $\theta_{JA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

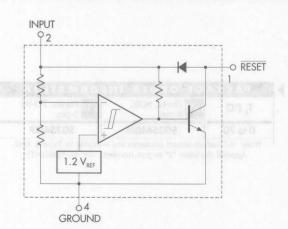
### PACKAGE PIN OUTS

> DM PACKAGE (Top View)

> > 3. GROUND
> > 2. INPUT
> > 1. RESET

LP PACKAGE (Top View)

### BLOCK DIAGRAM





### 3.3V Undervoltage Sensing Circuit

### PRODUCTION DATA SHEET

RECOMMENDED OPE	RATING C	ONDITION	S (Note 2)		
Parameter		Recommend	ed Operatin	g Conditions	Units
Faidilletei	Symbol	Min.	Тур.	Max.	Units
Input Supply Voltage		surrag1qagr ac	laatiov dio	10 gary gr 10 gaga	V
RESET Output Voltage		gever!	W Trotter or to	10	V
Clamp Diode Forward Current				50	mA
Operating Ambient Temperature Range:			SPIRE SER PICHE	DINAS PUNIDO 128	320 (5)
SG3546	T <sub>A</sub>	0	BUALIST BY	70	°C

Note 2. Range over which the device is guaranteed functional.

### **ELECTRICAL CHARACTERISTICS**

(Unless otherwise specified, these specifications apply over the operating ambient temperatures of  $0^{\circ}C \le T_{A} \le 70^{\circ}C$  for the SG3546. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions		SG3546		Units
Farailletei	Sylliooi	rest conditions	Min.	Тур.	Max.	Office
Total Device						
Operating Input Voltage Range	V <sub>IN</sub>		1.0	4/20	10	٧
Quiescent Input Current	I	$V_{IN} = 3.3V$		10	20	μA
		V <sub>IN</sub> = 10V		19	50	μA
Comparator Section						
Threshold Voltage						
High-State Output	V <sub>IH</sub>	V <sub>IN</sub> Increasing	2.75	2.81	3.0	٧
Low-State Output	V <sub>IL</sub>	V <sub>IN</sub> Decreasing	2.75	2.86	3.0	V
Hysteresis	V <sub>H</sub>			40		mV
RESET Output Section				8 W		
Output Sink Saturation	V <sub>OL</sub>	$V_{IN} = 2.6V, I_{SINK} = 1 \text{mA}$		0.05	0.40	٧
		$V_{IN} = 1.0V$ , $I_{SINK} = 100\mu A$		0.06	0.30	٧
Output Sink Current	I <sub>SINK</sub>	$V_{IN}$ , $\overline{RESET} = 2.6V$			20	mA
Output Off-State Leakage		V <sub>IN</sub> , RESET = 3.6V			0.5	μА
		V <sub>IN</sub> , RESET = 10V			2.0	μА
Clamp Diode Forward Voltage	V <sub>F</sub>	Pin 1 to pin 2, $(I_F = 5.0 \text{mA})$	0.5		1.2	٧

GRAPH / CURVE INDEX

### 3.3 V UNDERVOLTAGE SENSING CIRCUIT

PRODUCTION DATA SHEET

FIGURE INDEX

# Characteristic Curves FIGURE # 1. COMPARATOR THRESHOLD VOLTAGE vs. TEMPERATURE 2. RESET OUTPUT VOLTAGE vs. INPUT VOLTAGE 3. RESET OUTPUT VOLTAGE vs. INPUT VOLTAGE 4. INPUT CURRENT vs. INPUT VOLTAGE 5. RESET DELAY TIME (LOW to HIGH) 6. RESET DELAY TIME (HIGH to LOW) 9. VOLTAGE MONITOR 9. VOLTAGE MONITOR

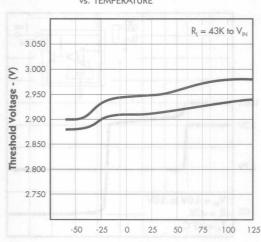
### 3.3V Undervoltage Sensing Circuit

### PRODUCTION DATA SHEET

### CHARACTERISTIC CURVES

FIGURE 1. — COMPARATOR THRESHOLD VOLTAGE

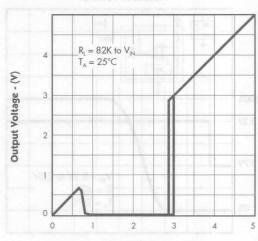
vs. TEMPERATURE



Junction Temperature - (°C)

FIGURE 2. — RESET OUTPUT VOLTAGE

vs. INPUT VOLTAGE



Input Voltage - (V)

FIGURE 3. — RESET OUTPUT SATURATION vs. SINK CURRENT

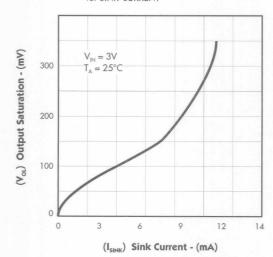
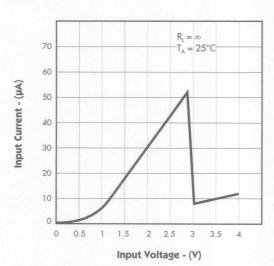


FIGURE 4. — INPUT CURRENT vs. INPUT VOLTAGE





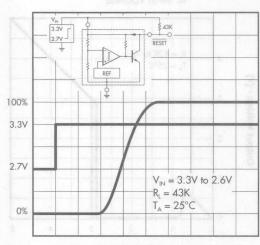
### SG3546

### 3.3V UNDERVOLTAGE SENSING CIRCUIT

PRODUCTION DATA SHEET

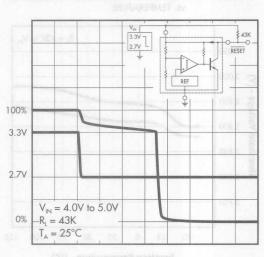
### CHARACTERISTIC CURVES

FIGURE 5. — RESET DELAY TIME (LOW TO HIGH)

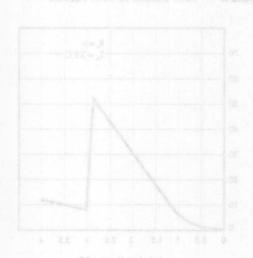


2µs/DIV.

### FIGURE 6. — RESET DELAY TIME (HIGH TO LOW)



0.5µs/DIV.

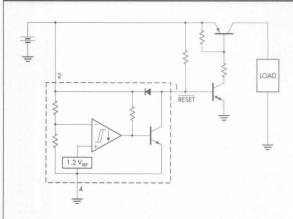




### 3.3V Undervoltage Sensing Circuit

### PRODUCTION DATA SHEET

### TYPICAL APPLICATION CIRCUITS



POWER SUPPLY

=

1.2 V<sub>err</sub>

MICROPROCESSOR
GIRCUIT

A time-delayed reset can be accomplished with the addition of  $C_{\scriptscriptstyle DLY}$  For systems with extremely fast power supply rise times (< 500ns), it is recommended that the  $RC_{\scriptscriptstyle DLY}$  time constant be greater than 5.0µs.  $V_{\scriptscriptstyle TH(MPU)}$  is the microprocessor reset input threshold.

$$t_{DLY} = R C_{DLY} In \left[ \frac{1}{1 - \frac{V_{TH(MPU)}}{V_{IN}}} \right]$$

FIGURE 7. — SWITCHING THE LOAD OFF WHEN BATTERY VOLTAGE REACHES BELOW V<sub>TU</sub>

FIGURE 8. — LOW VOLTAGE MICROPROCESSOR RESET

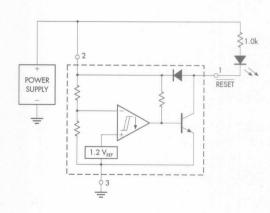
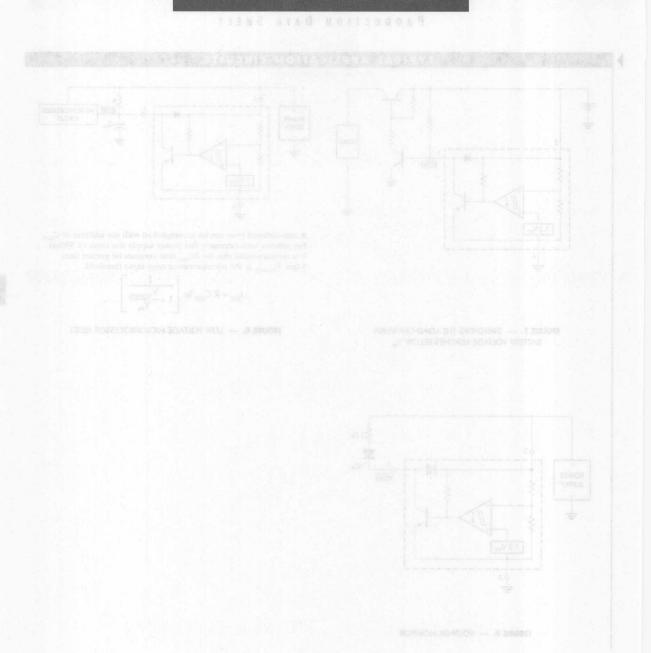


FIGURE 9. — VOLTAGE MONITOR

### Notes









THE INFINITE POWER OF INNOVATION NOT RECOMMENDED FOR NEW DESIGNS

### DESCRIPTION

This monolithic integrated circuit provides all the necessary functions for designing an active power factor correction circuit in conjunction with off-line power converters. Although the IC is optimized for electronic ballast applications, it can also be used in switched mode AC-DC power converters. Included in the 8-pin DIP package are; an under voltage lockout with a micropower start-up with a 2V hysteresis, an internal temperature compensated bandgap reference, a unity gain stable error amplifier, one quadrant multiplier stage, a current

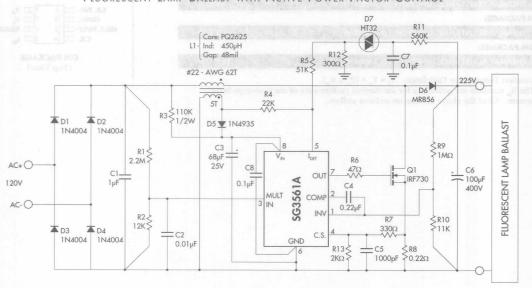
sense comparator and a totem pole output stage for directing driving of the power MOSFET. In addition to the above, an internal logic circuit detects the zero crossing of the inductor current and maintains discontinuous current mode of operation such that it allows no current gaps to appear. This type of operation provides a higher P.F. correction, as well as lower harmonic distortion over the fixed frequency discontinuous current mode. The SG3561A is characterized for operation over the ambient temperature range of -25°C to +85°C.

### **KEY FEATURES**

- MICRO-POWER START-UP MODE (250µA typ.)
- LOW OPERATING CURRENT CONSUMPTION
- INTERNAL 1.5% REFERENCE
- TOTEM POLE OUTPUT STAGE
- AUTOMATIC CURRENT LIMITING OF BOOST STAGE
- DISCONTINUOUS MODE OF OPERATION WITH NO CURRENT GAPS
- NO SLOPE COMPENSATION REQUIRED
- AVAILABLE IN 8 & 14-PIN PLASTIC DIP AND 8-PIN SOIC PACKAGE
- SEE LX1562/1563 FOR NEW DESIGNS

### PRODUCT HIGHLIGHT

TYPICAL APPLICATION OF THE SG3561A IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL



### PACKAGE ORDER INFORMATION M Plastic DIP DM Plastic SOIC Plastic DIP T, (°C) 14-pin 8-pin 8-pin -25 to 85 SG3561AM SG3561AN SG3561ADM

Note: All surface mount packages are available in Tape & Reel. Append the letter "T" to part number (i.e. SG3561ADMT)

FOR FURTHER INFORMATION CALL (714) 898-8121

### G3501A

### POWER FACTOR CONTROLLER

### 2801240 Wall 204 dad Not Recommended For New Designs

### ABSOLUTE MAXIMUM RATINGS (Note 1) Supply Voltage (VIN) ...... Peak Driver Output Current Driver Output Clamping Diodes $V_{Q} > V_{CC}$ or $V_{Q} < -0.3V$ ...... Detector Clamping Diodes $V_{DET} > 6V \text{ or } V_{DET} < 0.9V \dots$ Error Amp, Multiplier, and Comparator Input Voltages .....-0.3V to 6V Operating Junction Temperature Storage Temperature Range ......-65°C to 150°C Note 1. Values beyond which damage may occur. All voltages are specified with respect to ground, and all currents are positive into the specified terminal. Note 2. With no limiting resistor.

# THERMAL DATA M PACKAGE: THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{JA}$ N PACKAGE: THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{JA}$ DM PACKAGE: THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{JA}$ Junction Temperature Calculation: $T_1 = T_A + (P_D \times \theta_{JA})$ .

The  $\theta_{jk}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

### PACKAGE PIN OUTS E.A. INV. COMP. MULT. INPUT CS (Top View) E.A., | 3 12 | V<sub>IN</sub> 11 7 V. 10 GROUND N.C. MULT OUTPUT 8 C.S. N PACKAGE (Top View) E.A. INV. COMP. \_\_\_\_ 2 7 1 V. 6 GROUND MULT. INPUT 5 IDET C.S.

DM PACKAGE

(Top View)

### NOT RECOMMENDED FOR NEW DESIGNS

Baramatar	Cumbal	Recommen	Units		
Parameter	Symbol	Min.	Тур.	Max.	Units
Supply Voltage Range	V <sub>IN</sub>	11		25	V
Peak Driver Output Current			±300	t Voltage Range	mA
Operating Ambient Temperature Range:				Skuezi aberiek	ugal DM
SG3561A	T <sub>A</sub>	-25		85	°C

### **ELECTRICAL CHARACTERISTICS**

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for the SG3561A with -25°C  $\leq$  T<sub>A</sub>  $\leq$  +85°C; V<sub>IN</sub>=12V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Cumbal	Test Conditions		SG3561A		
Parameter	Symbol	lest Conditions	Min.	Тур.	Max.	Units
Under-Voltage Lockout Section			- I - I - I - I - I - I - I - I - I - I	and the same	14min 2 dis	over.
Start Threshold Voltage			9.2	10	10.8	٧
UV Lockout Hysteresis			1.6	2.0	2.4	٧
Supply Current Section		Augus		Veilade	to clare	funel
Start-Up Supply Current		$V_{IN} < V_{TH}$		0.25	0.5	mA
Operating Supply Current		V <sub>IN</sub> = 12V, Output Not Switching		6	12	mA
Dynamic Operating Supply Current	AVE	V <sub>IN</sub> = 12V, 50KHz, CGS = 1000pF	s Current	10	15	mA
Reference Section (Note 4)			- 1	r Secul	sylp@ his	Chuto
Initial Accuracy		I <sub>REF</sub> = 0mA, T <sub>J</sub> = 25°C	2.463	2.50	2.538	V
Line Regulation		12V < V <sub>IN</sub> < 25V		0.1	10	mV
Load Regulation		0 < I <sub>REF</sub> < 2mA		0.1	10	mV
Temperature Stability		**************************************		20	mil Holl St	mV
Error Amplifier Section						
Input Offset Voltage (Note 4)		and shown for shearns are according	-15	me wid	15	mV
Input Bias Current			-2	-0.1		μА
Large Signal Open Loop Voltage Gain		(Note 4)	60	86	31 E	dB
Slew Rate			100	0.6		v/µse
Power Supply Rejection Ratio (Note 4)		sed, is not tested in problement	60	86	21/11 10	dB
Output Source Current		V <sub>OH</sub> = 3.5V	2			mA
Output Sink Current		$V_{OL} = 2.0V$	2			mA
Output Voltage Range (Note 6)		No Load on E.A. Output	1.2		4	٧
Unity Gain Bandwidth				1.0		MHz
Phase Margin				57		0

(Electrical Characteristics continued next page.)



### NOT RECOMMENDED FOR NEW DESIGNS

			SG3561A			Units
Parameter	Symbol	Test Conditions	Min.	Тур.	Max.	Units
Multiplier Section						
M1 Input Voltage Range			0	muă Juci	2	٧
M2 Input Voltage Range			V <sub>REF</sub>	ngT Jasis	V <sub>REF</sub> +1	٧
Input Bias Current (M1)			-2		2	μА
Multiplier Gain (Note 5), (Note 4)		$V_{M1} = 1V, V_{EA0} = 3.5V$	0.52	0.65	0.78	N
		$V_{M1} = 2V, V_{EA0} = 3.5V$		0.65		Ν
Multiplier Gain Temperature Stability	A A STORY			-0.2	The same	%/°0
Maximum Multiplier Output Voltage		$V_{M1} = 1V, V_{EAO} > 4V$	Marie Marie	0.9		٧
I WAS TO THE WAY IN THE STORY HAVE AND	ALEGOR WILL	$V_{M1} = 2V, V_{EAO} > 4V$	HOUSE DESIGNATION	1.8	C TY ALESS TO THE	٧
<b>Current Sense Comparator Section</b>	on		CHECK CONTRACTOR			noniciaes
Input Bias Current		$0V \le V_{CS} \le 1.7V$	-5	1	5	μA
Current Sense Delay to Output		E.A. <sub>OUT</sub> = 3.7V	SE SENE	200	500	ns
Detect Section			10239E 100	Symbon at	6.9 1871.1 - 27	9KIFRI
Input Voltage Threshold			1	1.3	1.6	V
Hysteresis				175	ALL THEORY	mV
Input LO Clamp Voltage		$I_{DET} = 100\mu A$	110	F3396, 281	0.95	٧
Input HI Clamp Voltage		$I_{DET} = 3mA$	6.1	7.1	dans de	٧
Input Current		$1V \le V_{DET} \le 6V$	-10	MATCH AIG	10	μA
Input HI/LO Clamp Diode Current		$V_{DET} < 0.9V, V_{DET} > 6V$	phy Camilant	drig Sum	±3	mA
Output Driver Section						
Output High Voltage		$I_L = -10 \text{mA}, V_{IN} = 12 \text{V}$	7	9	Delugga	٧
Output Low Voltage		$I_L = 10 \text{mA}, V_{IN} = 12 \text{V}$		0.8	1.5	STV
Output Rise Time		C <sub>L</sub> = 1000pF		100	200	ns
Output Fall Time		$C_1 = 1000pF$		90	200	ns

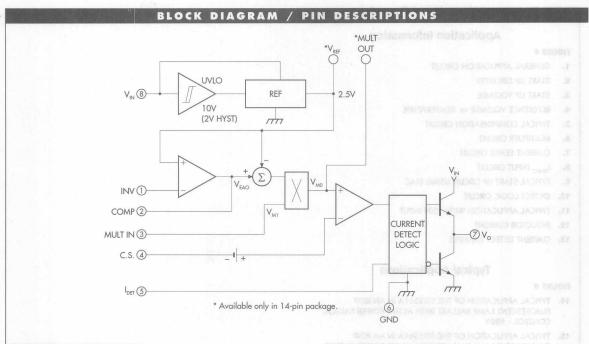
part. They are guaranteed by design, and shown for illustrative purposes only.

5. 
$$K = \frac{V_{MO}}{(V_{M}) \times (V_{EM} - V_{PE})}$$

6. This parameter, although guaranteed, is not tested in production.



### NOT RECOMMENDED FOR NEW DESIGNS



### **FUNCTIONAL DESCRIPTION**

Pin	#	Description
V <sub>IN</sub>	8	Input supply voltage. $V_{IN} \le 8V$ $I_{IN} \le 0.5 \text{mA}$ $V_{IN  MAX} < 25V$ $V_{IN} \ge 10V$ $I_{IN} \le 15 \text{mA}$
GND	6	Input supply voltage return. Must always be the lowest potential of all the pins.
INV	1	Inverting input of the Error Amplifier. The output of the Boost converter should be resistively divided to 2.5V and connected to this pin.
COMP	2	The output of the Error Amplifier. A feedback compensation network is placed between this pin and the INV pin.
MULT	3	Input to the multiplier stage. The full-wave rectified AC is divided to less than 2V and is connected to this pin.
C.S.	4	Input to the PWM comparator. Current is sensed in the Boost stage MOSFET by a resistor in the source lead, and is fed to this pin through a low-pass filter
I <sub>DET</sub>	5	A current driven logic input with internal clamp. A second winding on the Boost inductor senses the flyback voltage associated with the zero crossing of the inductor current and feeds it to the $I_{\text{DET}}$ pin through a limiting resistor. The logic circuit processes this signal, such that the converter operates in a discontinuous conduction current mode, where there is no current gap between the switching cycles.
Vo	7	PWM output pin. A totem-pole output stage specially designed for direct driving the MOSFET.

### SG3561A

### POWER FACTOR CONTROLLER

### NOT RECOMMENDED FOR NEW DESIGNS

### FIGURE INDEX

### **Application Information**

### FIGURE #

- 1. GENERAL APPLICATION CIRCUIT
- 2. START UP CIRCUITRY
- 3. START UP VOLTAGE
- 4. REFERENCE VOLTAGE vs. TEMPERATURE
- 5. TYPICAL COMPENSATION CIRCUIT
- 6. MULTIPLIER CIRCUIT
- 7. CURRENT SENSE CIRCUIT
- 8. I DETECT INPUT CIRCUIT
- 9. TYPICAL START UP CIRCUIT USING DIAC
- 10. IDETECT LOGIC CIRCUIT
- 11. TYPICAL APPLICATION WITH 120V INPUT
- 12. INDUCTOR CURRENT
- 13. CURRENT DETECT EXAMPLE

### **Typical Applications**

### FIGURE #

- TYPICAL APPLICATION OF THE SG3561A IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL - 120V
- TYPICAL APPLICATION OF THE SG3561A IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL - 220V
- 16. TYPICAL APPLICATION OF THE SG3561A IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL - 277\(\times\)
- 17. TYPICAL APPLICATION OF THE SG3561A IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL 277Y (BUCK BOOST APPLICATION)



### NOT RECOMMENDED FOR NEW DESIGNS

### APPLICATION INFORMATION

### **FUNCTIONAL DESCRIPTION**

The operation of the circuit is best described by referring to the diagram in Figure 1.

The multiplier stage generates an output voltage  $(V_{MD})$  from the rectified waveform of the AC input  $(V_{MI})$  and the amplitude of the error amplifier output  $(V_{EA})$ . This voltage controls the peak inductor current by turning the power MOSFET off at a threshold, where the current sense voltage  $(V_{C})$  reaches a given nominal value. This causes the power MOSFET to latch-off until the current in the inductor drops to zero. Once this happens, the secondary winding of the inductor changes its voltage polarity, and gets detected by an internal comparator stage. The polarity of the windings are chosen such that a low  $I_{DET}$  voltage turns on the power MOSFET and maintains operation until the above process repeats itself. An external trigger voltage to the IDET is required to start-up the converter until the auxiliary winding of the inductor takes over the operation.

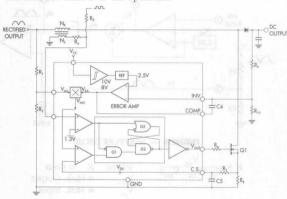


FIGURE 1 — GENERAL APPLICATION CIRCUIT

### UNDERVOLTAGE LOCKOUT

The purpose of the undervoltage lockout is to perform two functions: 1) to maintain a low quiescent current during power-up, 2) to guarantee that the IC is fully functional before the output stage is activated. To realize this, a micropower comparator with a start-up threshold of 10V and a built-in hysteresis of 2V is incorporated. This comparator acts as a switch for the pre-regulator stage, which supplies a stable bias to the internal circuitry of the IC. Figure 2 shows a simplified schematic of this section, as well as the external components required, inorder to generate bootstraping voltage from the secondary winding of inductor. The operation of the circuitry is as follows.

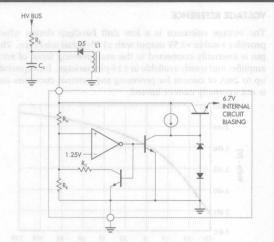


FIGURE 2 - START UP CIRCUITRY

Start-up capacitor  $C_3$  is first charged by the current through resistor  $R_3$ . Once this voltage exceeds 10V, then the IC starts operating, requiring more supply current than  $R_3$  can provide. This causes the energy stored in the capacitor to supply the IC with the operating current until the bootstrap winding on L1 takes over the power to maintain operation.

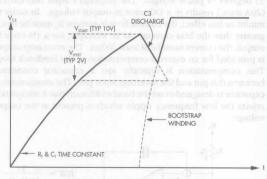


FIGURE 3 — START UP VOLTAGE

$$V_{\text{START}} = 1.25 \left[ \frac{R_{\text{A}}}{R_{\text{B}} \parallel R_{\text{C}}} + 1 \right] \quad V_{\text{HYST}} = 1.25 \frac{R_{\text{A}}}{R_{\text{C}}}$$



### APPLICATION INFORMATION

### **VOLTAGE REFERENCE**

The voltage reference is a low drift bandgap design which provides a stable +2.5V output with ±1.5% initial tolerance. This pin is internally connected to the non-inverting input of error amplifier and is only available in a 14-pin package. It can provide up to 2mA of current for powering any external circuitries and is not internally current limited.

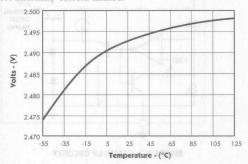


FIGURE 4 — REFERENCE VOLTAGE vs. TEMPERATURE

### ERROR AMPLIFIER

The error amplifier is an internally compensated PNP input stage with access to the inverting input and output pin. The N.I. input is internally connected to the voltage reference and is available only in a 14-pin package. The amplifier is designed for an open loop gain of 85dB, along with a typical bandwidth of 1MHz and 57 degrees of phase margin. The amplifier's input bias current (2µA max.) results in a DC error in output voltage. In order to minimize this effect, the current flow in resistor R<sub>o</sub> must be much greater than the bias current; As an example, for a 1% error in output, the current must be at least 200µA. The error amp output is provided for an external compensation of the feedback loop. This compensation is typically just a capacitor connected between this pin and the inverting input pin. The compensation capacitor is designed to set the bandwidth such that it adequately rejects the low frequency ripple which is present at the output voltage.

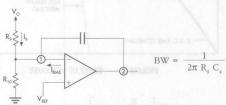


FIGURE 5 — TYPICAL COMPENSATION CIRCUIT

### MULTIPLIER

The SG3561A features a one quadrant multiplier stage having two inputs: one is internally driven by a DC voltage (this being the difference of E.A. output and  $V_{\rm RFF}$  (M2)), and the other (M1) is available for external connection. The output is internally tied to an input of the PWM comparator. The rectified AC input is typically divided down to less than 1V and is connected to the "M1" input by a resistor divider. The output of the multiplier which is a function of both inputs, controls the inductor peak current during each cycle of operation.

The multiplier is mostly linear if the M1 input is limited to less than 1V and the E.A. output is kept below 3.5V (under all specified load and line conditions). The output clamps to a maximum value of 0.9V typically if the E.A. output is higher than 4V and  $V_{M1} = 1V$ .

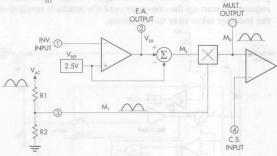


FIGURE 6 - MULTIPLIER CIRCUIT

$$\begin{split} K = \frac{V_{M0}}{V_{M1} \left(V_{EA} - V_{REP}\right)} & \text{where:} \quad K \equiv Gain \\ V_{M0} & \equiv \text{Mult. Output} \\ V_{M1} & \equiv \text{Mult. Input} \\ V_{EA} & \equiv E.A. \text{ Output} \end{split}$$

### **CURRENT SENSE COMPARATOR / PWM LATCH**

Current Sense comparator is configured as a PNP input differential stage with one input internally tied to the multiplier output and the other available for current sensing. Current is converted to voltage using an external sense resistor in a series with the power MOSFET (Q1). When voltage across this resistor exceeds the threshold set by the multiplier output, the current sense comparator terminates the gate drive to Q1, as well as resetting the PWM latch. The latch ensures that the output remains in a low state once the switch current falls back to zero.

An offset is built into current sense input to ensure that the output remains in a low state when the load is removed from the output of the converter. This offset is guaranteed to be higher than the multiplier offset during the above condition.

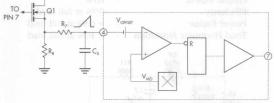
### NOT RECOMMENDED FOR NEW DESIGNS

### APPLICATION INFORMATION

### **CURRENT SENSE COMPARATOR / PWM LATCH** (continued)

Sense resistor  $R_8$  is designed according to the following formula:

$$R8 \leq \frac{V_{M0}}{I_{L_{MAX}}} \qquad \text{where:} \quad K \equiv Gain \\ V_{M0} \equiv \text{Mult. Output under} \\ \text{min. line condition} \\ V_{M1} \equiv \text{Mult. Input} \\ V_{EA} \equiv E.A. \text{ Output} \\ \end{cases}$$



R7 and C5 form a low pass filter to eliminate the leading edge current spike.

FIGURE 7 — CURRENT SENSE CIRCUIT

### **PWM DRIVER STAGE**

The SG3561A output driver is designed for direct driving of power MOSFETs. It is a totem pole stage with  $\pm 0.5$ A peak current capability. This typically results in a 100 nanosecond rise and fall times into a 1000pF capacitive load. Additionally, the output is held low during the under voltage condition to ensure that the power MOSFET remains in the off state.

### **CURRENT DETECT LOGIC**

The function of "current detect logic" is to sense the operating state of the boose inductor and to enable the output driver accordingly. To achieve this, the downward slope of the inductor current is detected by monitoring the voltage across a separate winding and is connected to the detector input ( $I_{\rm DET}$ ) pin. Once the inductor current drops to zero, the sensed voltage reverses, setting the  $I_{\rm DET}$  input to a low-level, thus enabling the output driver. Since this is a negative voltage, a level shifter as shown in Figure 8 is provided to prevent the  $I_{\rm DET}$  pin from going below the ground. The maximum current drawn from this pin must be limited to less than 3mA.

A high level voltage occurs when the inductor discharges. Referring to Figure 9, once the C.S. comparator inhibits the output driver and resets the flip-flop, the inductor voltage reverses and sets the I<sub>DET</sub> pin to a high level. This ensures the reset instruction of the current sense comparator and reduces its noise susceptibility. An internal zener diode with maximum current capability of 3mA limits the positive voltage swing to 7 volts typically.

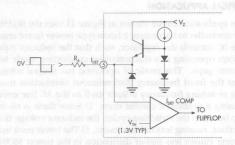


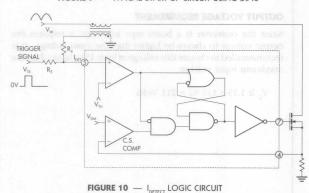
FIGURE 8 — IDETECT INPUT CIRCUIT

Since the output driver is inhibited during the power-on cycle, an external trigger signal is required to start-up the converter before the  $I_{\rm DET}$  winding takes over the operation. The trigger signal can be derived either from the second stage of the converter (i.e. the ballast voltage generator), or if stand alone operation is desired from a circuit as shown in Figure 9. Additionally, this signal should be low enough that the voltage from the detector winding is allowed to dominate during the normal operation.

The equations below describe the selection of  $\rm R_4$  and  $\rm R_5$  in Figure 10.

$$2500 \ V_{WP} \ge R_4 \ge 400 V_{WP} \qquad \text{where} \quad V_{WP} \equiv \text{Peak detector} \\ R_5 = 0.8 \ R_4 \left( \frac{V_{TR}}{1.6} \right) \qquad V_{TR} \equiv \text{Trigger voltage} \\ V_{R} = \frac{10}{100} V_{RES} R_5 \qquad V_{O} = \frac{R_{11}}{100} V_{O}$$

FIGURE 9 — TYPICAL START UP CIRCUIT USING DIAC



**C**LINFINITY

### NOT RECOMMENDED FOR NEW DESIGNS

### APPLICATION INFORMATION

### TYPICAL APPLICATION

The application circuit shown in Figure 11 uses the SG3561A as the controller to implement a boost type power factor regulator. The IC controls the regulator, such that the inductor current is always operating in a discontinuous conduction mode with no current gaps. This mode of operation has several advantages over the fixed frequency discontinuous conduction mode: 1) The switching frequency adjusts itself to the AC line envelope, causing a sinusoidal current draw, 2) Since there is no current gap between the switching cycles, the inductor voltage does not oscillate, causing less radiated noise, 3) The lower peak inductor current causes less power dissipation in the power MOSFET.

A set of formulas have been derived specifically for this mode, and are used throughout the design procedure:

The following are specifications for the boost converter:

Input Voltage Range

- 100 to 130V RMS

Output Voltage Output Power - 230V DC - 80W

Efficiency

95% at full load > 0.99 at full load

Power Factor -Total Harmonic Distortion -

< 10% at full load

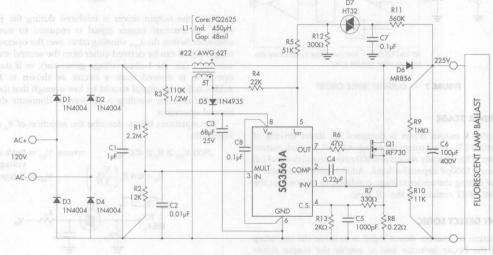


FIGURE 11 — TYPICAL APPLICATION WITH 120V INPUT

### **OUTPUT VOLTAGE REQUIREMENT**

Since the converter is a boost type topology, it requires the output voltage to always be higher than the input voltage. It is recommended to choose this voltage at least 15% higher than the maximum input voltage.

 $V_0 \ge 1.15 * 130 \sqrt{2} = 211 \text{ Volts}$ 

### INDUCTOR PEAK CURRENT

It can be shown by referring to Figure 12 that the inductor peak current is always twice the average input current.

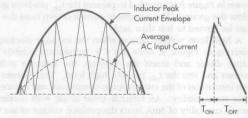


FIGURE 12 — INDUCTOR CURRENT



### NOT RECOMMENDED FOR NEW DESIGNS

### APPLICATION INFORMATION

### INDUCTOR PEAK CURRENT (continued)

$$I_{\text{INO}} = \sum_{l} \text{AVE} \left[ I_{l} \left( t \right) \right]$$

$$I_{\text{IN}} = \frac{1}{T} \left[ \frac{\left( I_{l} \right) \left( T \right)}{2} \right] \frac{I_{l}}{2}$$

I<sub>LP</sub> = Inductor peak current at peak input voltage.

Maximum peak input current can be calculated by using:

$$I_{p} = \frac{2P_{o}}{\eta V_{p}}$$

where:  $\eta \equiv \text{Converter efficiency}$   $V_p \equiv \text{Peak AC input voltage}$ 

assuming: 
$$\eta = 95\%$$
,  $P_O = 80W$ ,  $V_{Pmin} = 100\sqrt{2} = 141$   $I_P = \frac{2*80}{(.95)(141)} = 1.2A$   $I_{IP/min,AC} = 2*1.2 = 2.4A$ 

### INDUCTOR DESIGN

The most important part of the circuit is to design the energy storage element. To do this, we use the following equation to calculate the inductance value:

Idulate the inductance value: 
$$L_1 = \frac{\eta \frac{V_0 - V_p}{V_0} T V_p^2}{4 P_0} \quad \text{where: } \eta \equiv \text{Efficiency}$$

$$V_0 \equiv \text{Output DC Voltage}$$

$$V_p \equiv \text{Peak AC Input Voltage}$$

$$T \equiv \text{Switching period}$$

$$P_0 \equiv \text{Output Power}$$

$$L_{1} = \frac{.95 \left(\frac{230 - 120 \sqrt{2}}{230}\right) 20 * 10^{-6} * (120 \sqrt{2})^{2}}{4 * 80} = 448 \mu H$$

Once the inductance is calculated, we can either use the area product method (AP) or other K<sub>e</sub> (based on copper losses method), for selecting proper core. In this example, we apply the K approach using the following steps:

### Step 1: Calculate K using

$$K_g = \frac{\Omega}{P_{CU}} \left( \frac{L_1 I_{LP}^2}{B} \right)^2$$

where: L, = Required inductance

 $\Omega \equiv 1.724 * 10^{-8} \text{ m}$ 

B ≡ Maximum flux density

 $I_{LP} \equiv Maximum peak inductor current P_{CU} \equiv Maximum copper dissipation$ 

### INDUCTOR DESIGN (continued)

Assume: 
$$P_{CU} = 1.6W$$
 (2% of total output)  
 $K_g = \frac{1.724 * 10^{.8}}{1.6} \left[ \frac{450 * 10^{.6} * (2.4)^2}{0.15} \right]^2 = 3.21 * 10^{.12} \text{ m}^5$ 

Step 2: Choose a core with higher  $K_g$  than the one calculated

$$K_g/\text{core} = k \frac{A_w A_e^2}{I_w}$$

 $\begin{array}{lll} \text{where:} & k & \equiv \text{Winding coefficient (typ. k=0.4)} \\ & A_{\text{w}} & \equiv \text{Bobbin window area} \\ & A_{\text{E}} & \equiv \text{Effective core area} \\ & I_{\text{w}} & \equiv \text{Mean length per turn} \end{array}$ 

$$K_g$$
 factor for TDK PQ2625:  
 $A_W = 47.7 \text{mm}^2$   
 $A_E = 118 \text{mm}^2$   
 $I_W = 56.2 \text{mm}$ 

$$A_E^w = 118 \text{mm}^2$$
 $I_W = 56.2 \text{mm}$ 
 $K_g = 0.4 \frac{(47.7) (118)^2}{56.2} (\text{mm})^5 = 4.7 \cdot 10^{-12} \text{ m}^5$ 

### Step 3: Determine number of turns.

N = 
$$\frac{\text{L I}_{\text{IP}}}{\text{B A}_{\text{E}}}$$
  
N =  $\frac{450 \cdot 10^6 \cdot 2.4}{0.15 \cdot 118 \cdot 10^6}$  = 61 turns  

$$A_{\text{WIRE}} = k \frac{A_{\text{w}}}{N} = 0.4 \frac{47.7}{61} = 0.31 \text{mm}^2$$
= 480mil<sup>2</sup>

choose #22 AWG with  $r = 0.0165\Omega/feet$  resistance.

$$R_{w} = N * I_{w} * r$$

$$R_{w} = 0.185\Omega$$

### Step 4: Calculate air gap.

$$I_{g} = \frac{\mu_{o} N^{2} A_{E}}{L}$$

$$I_{q} = \frac{4\pi * 10^{.7} * (61)^{2} * 118 * 10^{.6}}{450 * 10^{.6}} = 0.122 cm = 48 mil$$

Step 5: 
$$N_s \approx N_p \frac{V_s}{V_o}$$

$$N_s = 61 \frac{15}{230} = 4T \text{ where: } V_s \equiv \text{secondary voltage}$$

N<sub>e</sub> may be adjusted to account for the drop in start-up capacitor.

### APPLICATION INFORMATION

### **POWER MOSFET SELECTION**

The voltage rating of MOSFET and rectifier must be higher than the maximum value of the output voltage.

$$V_{DS} \ge 1.2V_{OMAX}$$
  $V_{DS}$ 

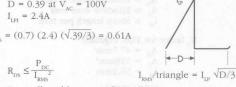
The RMS current can be approximated by multiplying the RMS current at the peak of the line by 0.7.

$$I_{_{RMS}} = 0.7 \; I_{_{LP}} \; \sqrt{D/3} \qquad \qquad D \equiv \text{On-time duty cycle}$$

D = 0.39 at 
$$V_{AC}$$
 = 100V  $I_{LPI}$  = 2.4A

$$I_{LPI} = 2.4A$$

$$I_{RMS} = (0.7) (2.4) (\sqrt{.39/3}) = 0.61A$$



$$R_{DS} \le \frac{P_{DC}}{I_{RMS}^2}$$

$$I_{RMS}/triangle = I_{LP} \sqrt{D/3}$$

 $P_{DC} \equiv$  allowable power dissipation

$$R_{DS} \le \frac{1}{0.61}$$

choose IRF730 with  $R_{DS} = 1\Omega$  and  $V_{DS} = 400V$ .

### **CURRENT SENSE AND MULTIPLIER COMPONENT SELECTION**

Resistors R, and R, are selected such that the peak voltage at M1 input (pin 3) is 1V at the maximum line voltage.

$$\frac{R_1}{R_2} = V_{AC PEAK} - 1$$

$$\frac{R_1}{R} = 18$$

$$\frac{R_1^2}{R_2} = 183$$
 if  $R_1 = 2.2M$  then  $R_2 = 12K$ 

The value of R<sub>o</sub> can be selected using the following equations:

$$V_{_{M0}} = k V_{_{M2}} * V_{_{M}}$$

 $V_{_{M0}} = k \ V_{_{M2}} * V_{_{M1}} \qquad V_{_{M1}} = \mbox{Maximum voltage at M1 input} \\ \mbox{under min. line condition}$ 

$$V_{M0} = (0.75) (3.5 - 2.5) (0.77) = 0.58$$

$$R_8 = \frac{V_{MO}}{I_{LP}} = \frac{0.58}{2.4} = \frac{0.58}{2.4} = 0.24\Omega$$
 choose  $R_8 = 0.22\Omega$ 

choose 
$$R_8 = 0.22\Omega$$

To eliminate the turn-on current spike, a low pass filter with a high corner frequency must be designed such that:

R\_C. ≥ 0.16usec

assuming 
$$C_4 = 1000pF$$

### The values of R, and C, may be optimized further based on each specific application. Additionally R, can be used to

adjust the overall loop gain in order to maintain regulation at the minimum input voltage.

### **ERROR AMPLIFIER COMPONENT SELECTION**

The values of R<sub>0</sub> and R<sub>10</sub> are calculated based on the operating output voltage. The value of C, is mainly selected to reject the 120Hz ripple associated with the output voltage. Lack of adequate ripple rejection causes input current distortion; however, too much rejection will make a slow loop response and a high voltage overshoot during the turn-on.

$$\frac{R_9}{R} = \frac{V_O}{V} - 1$$

$$\frac{R_{9}}{R_{10}} = \frac{V_{O}}{V_{REF}} - 1$$

$$\frac{R_{9}}{R_{10}} = \frac{230}{2.5} - 1 = 91$$
assuming  $R_{9} = 1M\Omega$  Then:  $R_{10} = 11K$ 

assuming 
$$R_0 = 1M\Omega$$
 Then:  $R_{10} = 11K$ 

For output voltages higher than 250V, safety regulations may require two ¼W resistors to be placed in series.

Assuming a 40dB rejection at 120Hz:

Gain = 
$$\frac{1}{2\pi f R_9 C_5}$$
 Gain/120Hz  $\leq 0.01$ 

$$C_5 \ge \frac{100}{2\pi(120)(10^6)}$$

$$C_5 \ge 0.133 \mu f$$
 choose  $C_5 = 0.22 \mu f$ 

BW = 
$$\frac{1}{2\pi R_9 C_5}$$
 =  $\frac{1}{2\pi (10^6)(.22 * 10^{-6})}$  = 0.72Hz

### INPUT RECTIFIER AND CAPACITOR SELECTION

The current through each diode is a half-wave rectified sine wave. The maximum current happens at minimum line with a peak value of 1.2A.

$$I_{AVE} = \frac{I_{PEAK}}{\pi} = \frac{1.2}{\pi} = 0.38A$$

choose 1N4004 with 1A rating.

$$P_{DISS} = (I_{AVE}) (V_{E}) = 0.38 * 0.9 = 0.344W$$

$$T_{I} = T_{A} + P_{D} \times \theta$$

 $T_J = T_A + P_D \times \theta_{JA}$  assuming  $\theta_{JA} = 65^{\circ}\text{C/W}$  for  $1/8^{\circ}$  lead length.

$$T_r = 80 + (.344)(65) = 102$$
°C

### Power Factor Controller

### NOT RECOMMENDED FOR NEW DESIGNS

### APPLICATION INFORMATION

### INPUT RECTIFIER AND CAPACITOR SELECTION (continued)

Assuming  $\varphi$  is the percentage of allowable input current ripple, C, can be calculated using the following equations:

$$R_{EFF} = \frac{2 P_{O}}{\eta I_{P}^{2}}$$

$$C_1 \ge \frac{1}{\phi 2\pi R_{EFF} f_{SW}}$$

 $C_{_1} \ge \frac{1}{\phi \ 2\pi \ R_{_{EFF}} \ f_{_{SW}}}$   $f_{_{SW}} \equiv$  Switching frequency of inductor current

if  $\varphi = 3\%$ 

$$R_{EFF} = \frac{2 * 80}{(.95)(1.2)^2} = 117\Omega$$

$$C_1 \ge \frac{1}{(.03)(2\pi)(117)(50000)} = 0.9\mu F$$

choose 1uF, 250V capacitor.

### **BIAS SUPPLY COMPONENT SELECTION**

A bleeding resistor (R2) off of either output voltage or capacitor C, can be selected such that it provides sufficient start-up current for the IC, as well as charging the start-up capacitor C<sub>a</sub>.

$$R_3 = \frac{V_{PMIN}}{I_{ST}}$$

$$R_3 = \frac{140}{1} = 280K$$

 $\begin{array}{lll} R_3 = \frac{V_{P\,MIN}}{I_{ST}} & I_{ST} & \equiv Start-up\ current \\ R_3 = \frac{140}{0.5*10^3} = 280K & V_{P\,MIN} & \equiv Peak\ AC\ voltage\ at\ min.\ AC\ line \\ P_{R3} = \frac{V_{IN\,MAX}}{R_3} \leq 0.25W & V_{IN\,MAX} & \equiv Max.\ RMS\ input \end{array}$ 

$$P_{R3} = \frac{V_{IN MAX}}{R_3} \le 0.25W$$

 $R_3 \ge 4V_{IN\ MAX}^2$ 

 $280K \ge R_{2} \ge 68K$ 

choose  $R_3 = 110K$ 

The start-up capacitor must be chosen such that it supplies power to the IC until the voltage on the bootstrap winding exceeds the start threshold (this is typically around 10 volts). C<sub>3</sub> must also be designed to have low ripple voltage at twice the line

$$C_3 (\Delta V_R) \ge \frac{I}{2 f_{LINE} \Delta V_R}$$

 $\begin{array}{c} C_{_{3}}\left(\Delta V_{_{R}}\right) \geq \frac{I}{2\;f_{_{LINE}}\;\Delta V_{_{R}}} & I \equiv \text{Operating current} \\ f_{_{LINE}} \equiv \text{Line frequency} \\ \Delta V_{_{1}} \equiv \text{Ripple voltage} \\ C_{_{3}}\left(\Delta T\right) \geq \frac{I\Delta T}{\Delta V_{_{H}}} & \Delta T \equiv \text{Time allowed for bootstrap} \\ & \text{winding to reach start-up} \end{array}$ threshold

$$C_3 (\Delta V_R) \ge \frac{15 * 10^{-3}}{2 * 60 * 2} = 62 \mu F$$

assuming  $\Delta T = 2ms$ 

$$C_3 (\Delta T) \ge \frac{15 * 10^{-3} * 2 * 10^{-3}}{1.8 V} = 17 \mu f$$

### **OUTPUT CAPACITOR SELECTION**

There are mainly two criterias for selecting the output capacitor: A large enough capacitance to maintain a low ripple voltage, and a low ESR value in order to prevent high power dissipation due to RMS currents.

The output capacitance can be approximated from the following equation:

$$C_6 \geq \frac{I_{DC}}{2\pi \; f_{LINE} \; \Delta V} \qquad \text{where: } I_{DC} \; \equiv DC \; \text{output current} \\ \Delta V \; \equiv \text{Output ripple}$$

$$I_{DC} = \frac{80}{230} = 0.348A$$

assuming 5% peak to peak ripple,

$$C_6 \ge \frac{0.348}{2\pi (60) (11.5)} = 81 \mu F$$

choose  $C_6 = 100 \mu F$ .

### **CURRENT DETECT COMPONENT SELECTION**

The values of  $R_{_{\! 4}}$  and  $R_{_{\! 5}}$  can be calculated using the following equations:

 $400V_{wp} \ge R_4 \ge 2500V_{wp}$ 

$$R_5 = 0.8R_4 \left( \frac{V_{TR}}{1.6} \right)$$

where:

V<sub>wP</sub> ≡ Maximum detector winding voltage

 $V_{TR} \equiv Trigger voltage$ 

### NOT RECOMMENDED FOR NEW DESIGNS

### APPLICATION INFORMATION

### **CURRENT DETECT COMPONENT SELECTION** (continued)

Assuming  $V_{wp}$  = 15V and peak trigger voltage from the start-up circuitry is 7V, the values  $R_s$  and  $R_s$  using above formulas are:

$$6K\Omega \le R_4 \le 37.5K\Omega$$

$$R5 = 0.8 (22) \left( \frac{7}{1.6} - 1 \right) = 59.4 \text{K}\Omega$$
 choose

choose  $R_5 = 51K$ 

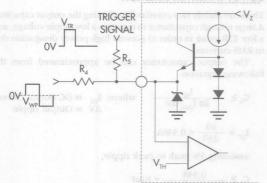


FIGURE 13 — CURRENT DETECT EXAMPLE

L = Shart-up current

= 280K V yass = Peak AC vollage at

Name of the Name o

dioose R = 110K

be atam-up expaction must be chosen such that it supplies ower to the JC until the voltage on the hootstrap winding secrets the start threshold (this is typically around 10 volts). C, ust elso buildesigned to have low ripple voltage activities the line sequency.

Coperating various
 finis = Line frequency
 Av = Rippie voltage
 AT = Time allowed for lost

 $\frac{TA1}{\sqrt{\Delta}} \le (7\Delta) \sqrt{2}$ 

 $|3 \times 2| = \frac{15 + 10^3}{2 \times 60 + 2} = 62$ 

### NOT RECOMMENDED FOR NEW DESIGNS

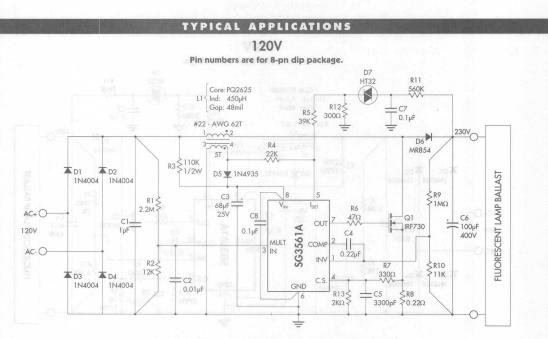


FIGURE 14 — TYPICAL APPLICATION OF THE SG3561A IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL.

Ref.	Component	Manuf.	Ref.	Component		Manuf.
C L1 Q1 D1-D4 D5 D6 D7 R1 R2 R3 R4 R8 R9 R10 R11 R12 R13	SG3561AM   PQ2625/H7C1 Core   IRF730, 400V   1N4004, Diode, 1A   1N4935, Diode, 1A   MR854, 3A, 400V   HT32, DIAC   2.2MΩ   12KΩ   110K, ½W   22K   51K   47Ω   330Ω   0.22Ω, ½W - Carbon type   1MΩ, 1% Res   11KΩ, 1% Res   560KΩ   300Ω   2KΩ   2KΩ	Motorola Motorola Motorola TECCOR	C1 C2 C3 C4 C5 C6 C7 C8	1μF/250V 0.01μF/50V 68μF/25V 0.22μF/50V 3300pF/50V 100μF/400V 0.1μF/50V	563561A 10263/H7C1 Core 87830, 800V INMOS, Diede, 1A INMS5, Diede, 1A 4885, 3A, 800V 4732, DIAC 2,2MQ 2,2MQ 2,2MQ 2,2MQ 2,2MQ 1,2KQ 1,2KQ 1,2KQ 1,2KQ 1,0K	IC (II (II (II (II (II (II (II (II (II (



# SG3561A

# POWER FACTOR CONTROLLER

## NOT RECOMMENDED FOR NEW DESIGNS

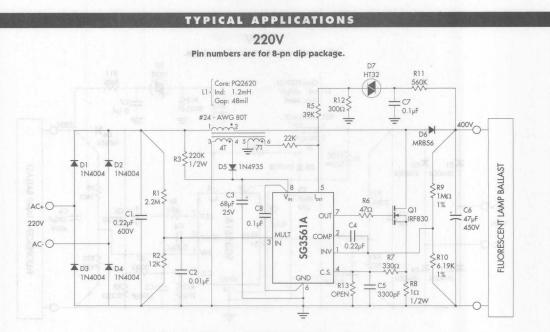


FIGURE 15 — TYPICAL APPLICATION OF THE SG3561A IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL.

Ref.	Component	Manuf.	Ref.	Component	Manuf.
C .1 .1 .1 .1 .1 .1 .1 .1 .1 .1 .1 .1 .1	110001 01 10011	Linfinity TDK I.R. Motorola Motorola Teccor	C1 C2 C3 C4 C5 C6 C7 C8	3300pF/50V	C SCESETAM  COLOR SCENETAM  CO



# POWER FACTOR CONTROLLER

## NOT RECOMMENDED FOR NEW DESIGNS

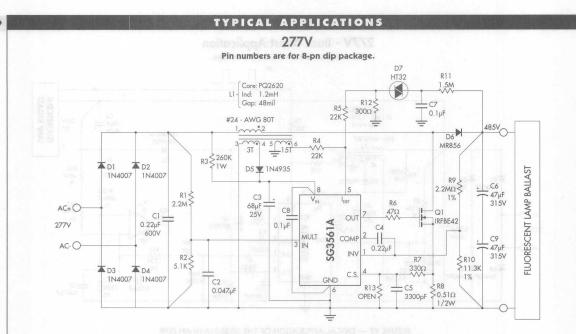


FIGURE 16 — TYPICAL APPLICATION OF THE SG3561A IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL.

Ref.	Component	Manuf.	Ref.	Component		Manuf.
IC L1 Q1 D1-D4 D5 D6 D7 R1 R2 R3 R4 R5 R6 R7 R8 R9 R10 R11 R112 R13	SG3561A PQ2620/H7C1 Core IRFBE42, 600V 1N4007, Diode, 1A 1N4935, Diode, 1A MR856, 3A, 600V HT32, DIAC 2.2MΩ 5.1KΩ 260KΩ, 1W 22KΩ 22KΩ 47Ω 330Ω 0.51Ω, ½W - Carbon type 2.2MΩ, 1% Res 11.3KΩ, 1% Res 1.5KΩ 300Ω	Motorola	C1 C2 C3 C4 C5 C6, C9 C7 C8	0.22µF/600V 0.047µF/50V 68µF/25V 0.22µF/50V 3300pF/50V 47µF/315V 0.1µF/50V	UM358N PG2450/H7Cl Core IRFRES 2, 800V 1 N4007, Diode, 1A 1 N4935, Diode, 1A 2, 21/45, 18 2, 21/45, 18 2, 21/45, 18 2, 21/45 2, 2	202 001-04 005 005 005 88 88 88 88 88 88 88 88 88 88 88 88 88

# SG3561A

# Power Factor Controller

# NOT RECOMMENDED FOR NEW DESIGNS

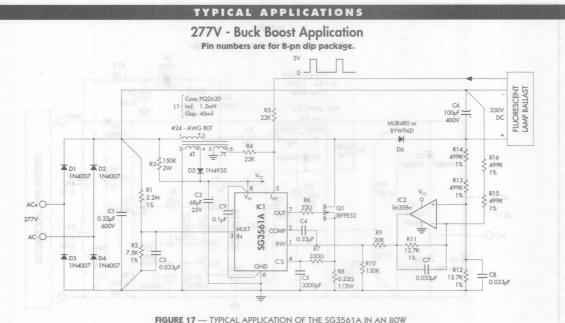


FIGURE 17 — TYPICAL APPLICATION OF THE SG3561A IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL.

Electrico Specific		_ 230VDC	/ 80W	Output	
Ref.	Component	Manuf.	Ref.	Component	Manuf.
C2 .1 Q1 D1-D4 D5 D6	LM358N PQ2620/H7Cl Core IRFPE52, 800V 1N4007, Diode, 1A 1N4935, Diode, 1A BYW96D, 4A, 800V 2.2MΩ, 1%		C2 C3 C4 C5 C6 C7, C8	0.033µF/50V 68µF/25V 0.22µF/50V 3300pF/50V 100µF/400V 0.033µF/50V 0.1µF/50V	01 PG 01 IRF 01-DA 1N 05 IN 06 MF
R2 R3 R4 R5 R6 R7	7.5KΩ, 1% 150K, 2W 22kΩ 22K 22Ω 330Ω	(i,0 83.		2MQ HQQ OKQQ TW KQ KQ OQ	R2 5.1 R3 26 R4 22 R5 22 R6 47
R8 R9 R10 R11 R12 R13, 14 R15, 16	0.22Ω, ½W 20K 130K 12.7K, 1% 12.7K, 1% 499K, 350V 499K, 350V			000 2MQ, 18 Rec 3KQ, 18 Rec 3KQ, 18 Rec 3KQ 0Q	RB 0.2 RP 2.1 R10 11



# POWER FACTOR CONTROLLER

# NOT RECOMMENDED FOR NEW DESIGNS

# TYPICAL APPLICATIONS

# 90 - 265V

Pin numbers are for 8-pn dip package.

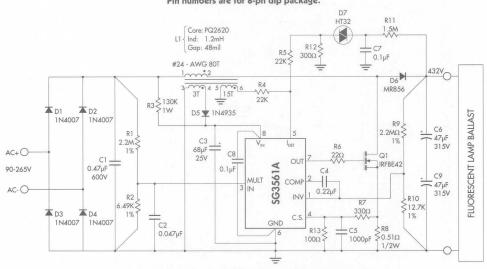


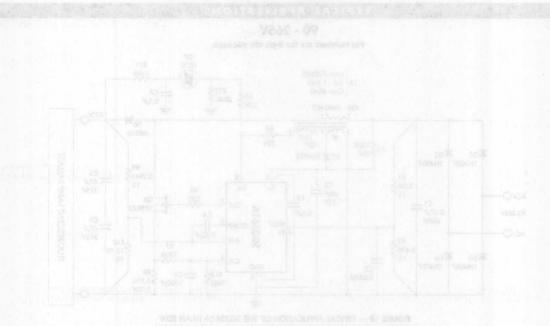
FIGURE 18 — TYPICAL APPLICATION OF THE SG3561A IN AN 80W FLUORESCENT LAMP BALLAST WITH ACTIVE POWER FACTOR CONTROL.

Ref.	Component	Manuf.	Ref.	Component	Manuf.
IC L1 Q1 D1-D4 D5 D6 D7 R1 R2 R3 R4 R5 R6 R7 R8 R9 R10 R11 R112 R113	SG3561A PQ2620/H7C1 Core IRFBE42, 600V 1N4007, Diode, 1A 1N4935, Diode, 1A MR856, 3A, 600V HT32, DIAC 2.2MΩ, 1% 6.49K, 1% 130K, 1W 22kΩ 22K 22Ω 330Ω 0.51Ω, ½W - Carbon type 2.2MΩ, 1% Res 12.7KΩ, 1% Res 1.5KΩ 300Ω 100Ω	Linfinity TDK I.R. Motorola Motorola TECCOR	C1 C2 C3 C4 C5 C6, C9 C7 C8	0.47µF/600V 0.047µF/50V 68µF/25V 0.22µF/50V 1000pF/50V 47µF/315V 0.1µF/50V	



# Notes

Not Recommended for New Besieus









PRECISION VOLTAGE REGULATOR

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

This monolithic voltage regulator is designed for use with either positive or negative supplies as a series, shunt, switching, or floating regulator with currents up to 150mA. Higher current requirements may be accommodated through the use of external NPN or PNP power transistors. This device

consists of a temperature compensated reference amplifier, error amplifier, power series pass transistor, current limit, and remote shutdown circuitry.

The SG723 will operate over the full military ambient temperature range of -55°C to 125°C.

Complete specifications available from "LIN" Fax System (See Page 4-1) and 1990/91 Silicon General Databook

#### KEY FEATURES

- POSITIVE OR NEGATIVE SUPPLY OPERATION
- SERIES, SHUNT, SWITCHING OR FLOATING OPERATION
- LOW LINE AND LOAD REGULATION
- OUTPUT ADJUSTABLE FROM 2V TO 37V
- OUTPUT CURRENT TO 150mA
- LOW STANDBY CURRENT DRAIN
- 0.002%/°C AVERAGE TEMPERATURE VARIATION

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- MIL-M38510/10201BHA JAN723F
- MIL-M38510/10201BIA JAN723T
- MIL-M38510/10201BCA JAN723J
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

#### PACKAGE PIN OUTS CURRENT LIMIT N.C. **CURRENT SENSE** FREQ. COMPENSATION **CURRENT LIMIT** 13 FREQ. COMPENSATION CURRENT SENSE 12 V<sub>IN</sub> 11 V<sub>C</sub> INVERTING INPUT INVERTING INPUT NON-INVERTING INPUT 10 Vout NON-INVERTING INPUT 5 9 7 Vz N.C. J PACKAGE T PACKAGE (Top View) (Top View) 3 2 1 20 19 1 FREQ COMP 11 N.C. 2. CURRENT LIMIT 12. V<sub>z</sub> 13. N.C. 3. CURRENT SENSE 1. CURRENT SENSE 10. CURRENT LIMIT 4. N.C. 14. V<sub>out</sub> 15. N.C. 17 2. INVERTING INPUT 9. FREQ. COMP. 5. INVERTING INPUT 3. N.I. INPUT 8. VIN 6. N.C. 16. N.C. 4. V<sub>REF</sub> 5. V-15 7. N.I. INPUT 17. N.C. 8. V<sub>REF</sub> 9. N.C. 18. V<sub>c</sub> 19. N.C. 10. V-20. VIN 9 10 11 12 13 F PACKAGE L PACKAGE (Top View) (Top View)

	PACK	AGE ORDER IN	FORMATION	
T <sub>A</sub> (°C)	J Ceramic DIP 14-pin	T T0-100 Metal Can 10-pin	F Ceramic Flatpack 10-pin	L Ceramic LCC 20-pin
-55 to 125	SG723J	SG723T		SG723L
MIL-STD-883	SG723J/883B	SG723T/883B	——————————————————————————————————————	SG723L/883B
JAN SPEC.	JAN723J	JAN723T	JAN723F	

FOR FURTHER INFORMATION CALL (714) 898-8121

# Notes

TRANS ATAO MOTTS DOOR 9

- IN POSITIVE OR NEGATIVE SUPPLY
- SERIES, SHUNT, SWITCHING OR FLOATING
  - NOWTHING AND LOAD REGULATION
- M OUTPUT ADJUSTABLE FROM SV TO 37V
  - ANALY OF THE SERVICE THE THE RE-
    - MARCH THOROUGH VERTILATE WAS IN
  - BIUTAVENIET BOARDVA DINJEROOD II
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First monolitic voluge orgulator is designed for use with either positive or negative supplies as a series, shart, switching, or floating regulator with currents in to 150mA. Higher current requirements now be notumodated through the use of external NPN or PNP power transistors. This device

#### SHIESS RELIGIOUS FEATURES

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- QMc 2630
- M AND ACTOR COLOROTED A CAMPOST
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- M DINEMAN TAKE AS SKOCESBING

Converte sercellocations available from "UIN" Fax System
(See Page 4-1) and 1990/91 Surgon General Datamodes

# CURRENT LIMIT CURRENT SENSE CURREN





# SG7800A/SG7800 Series

Positive Fixed Voltage Regulator

THE INFINITE POWER OF INNOVATION

NOT RECOMMENDED FOR NEW DESIGNS

#### DESCRIPTION

The SG7800A/SG7800 series of positive regulators offer self contained, fixedvoltage capability with up to 1.5A of load current and input voltage up to 50V (SG7800A series only). These units feature a unique on-chip trimming system to set the output voltages to within ±1.5% of nominal on the SG7800A series, ±2.0% on the SG7800 series. The SG7800A versions also offer much improved line and load regulation characteristics. Utilizing an improved bandgap reference design, problems have been eliminated that are normally associated with the Zener diode references, such as drift in output voltage and large changes in the line

and load regulation.

All protective features of thermal shutdown, current limiting, and safearea control have been designed into these units and since these regulators require only a small output capacitor for satisfactory performance, ease of application is assured.

Although designed as fixed-voltage regulators, the output voltage can be increased through the use of a simple voltage divider. The low quiescent drain current of the device insures good regulation when this method is used.

Product is available in hermetically sealed TO-257, TO-3, TO-39 and TO-66 power packages.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### KEY FEATURES

- OUTPUT VOLTAGE SET INTERNALLY TO ±1.5% ON SG7800A
- INPUT VOLTAGE RANGE TO 50V MAX. (SG7800A)
- TWO VOLT INPUT-OUTPUT DIFFERENTIAL
- EXCELLENT LINE AND LOAD REGULATION
- FOLDBACK CURRENT LIMITING
- THERMAL OVERLOAD PROTECTION
- VOLTAGES AVAILABLE: 5V, 6V, 8V, 12V, 15V, 18V, 20V, 24V

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- MIL-M38510/10702BXA-JAN7805T
- MIL-M38510/10706BYA-JAN7805K
- MIL-M38510/10703BXA-JAN7812T
- MIL-M38510/10707BYA-JAN7812K
- MIL-M38510/10704BXA-JAN7815T■ MIL-M38510/10708BYA-JAN7815K
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

(See next page for Package Pinouts)

NAME AND ADDRESS OF THE OWNER, WHEN PARTY OF T	TO 3 M + 1 C	TO (( M . 10	TO OCT II	TO 20 M . 1 C	. 100
T <sub>A</sub> (°C)	K TO-3 Metal Can 3-Terminal	R TO-66 Metal Can 3-Terminal	IG TO-257 Hermetic 3-pin (Isolated)	T TO-39 Metal Can 3-pin	L Ceramic LCC 20-pin
0 to 125	SG78xxK		25		_
-55 to 125	SG78xxAK*	SG78xxAR*	SG78xxAIG*	SG78xxAT*	
MIL-STD-883	SG78xxAK/883B*	SG78xxAR/883B*	SG78xxAIG/883B*	SG78xxAT/883B*	SG78xxL/883B
	JAN7805K	_		JAN7805T	-
JAN SPEC.	JAN7812K	_	_	JAN78012T	
	JAN7815K	_		JAN7815T	
	SG7805AK/DESC	SG7805AR/DESC	SG7805AIG/DESC	SG7805AT/DESC	SG7805AL/DESC
	SG7805AK/DESC	SG7806AR/DESC	-	SG7806AT/DESC	
DESC	SG7808AK/DESC	SG7808AR/DES	-	SG7808AT/DESC	_
DESC	SG7812AK/DESC	SG7812AR/DESC	SG7812AIG/DESC	SG7812AT/DESC	SG7812AL/DESC
	SG7815AK/DESC	SG7815AR/DESC	SG7815AIG/DESC	SG7815AT/DESC	SG7815AL/DESC
4.745	SG7824AK/DESC	SG7824AR/DESC		SG7824AT/DESC	

<sup>\* &</sup>quot;A" denotes improved performance over the non-"A" version, non-"A" versions also available.

"xx" to be replaced by output voltage of specific fixed regulator.

# **SG7800A/SG7800 Series**

# Positive Fixed Voltage Regulator

## and 123 G was 4 903 dag Not Recommended for New Designs

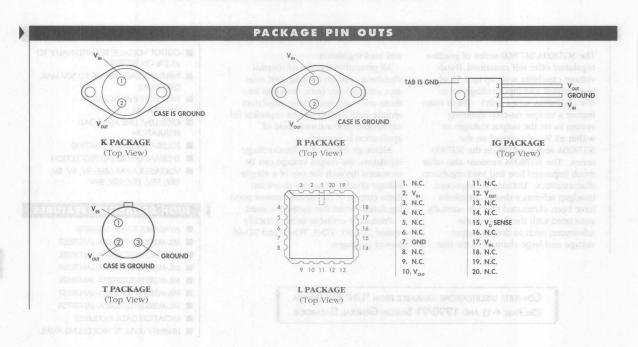


	Fig. 10-66 Meral Cun	
SGF812AT/DESC		



# SG7900A/SG7900 Series

# NEGATIVE FIXED VOLTAGE REGULATOR

THE INFINITE POWER OF INNOVATION

NOT RECOMMENDED FOR NEW DESIGNS

#### DESCRIPTION

The SG7900A/SG7900 series of negative regulators offer self-contained, fixed-voltage capability with up to 1.5A of load current. With a variety of output voltages and four package options this regulator series is an optimum complement to the SG7800A/SG7800, SG140 line of three terminal regulators.

These units feature a unique bandgap reference which allows the SG7900A series to be specified with an output voltage tolerance of ±1.5%. The SG7900A versions also offer much improved line regulation characteristics.

All protective features of thermal shutdown, current limiting, and safearea control have been designed into these units and, since these regulators require only a single output capacitor (SG7900 series) or a capacitor and 5mA minimum load (SG120 series) for satisfactory performance, ease of application is assured.

Although designed as fixed-voltage regulators, the output voltage can be increased through the use of a simple voltage divider. The low quiescent drain current of the device insures good regulation when this method is used, especially for the SG120 series.

These devices are available in hermetically sealed TO-257, TO-3, TO-39 and TO-66 power packages.

Complete specifications available from "LIN" Fax System (See Page 4-1) and 1990/91 Silicon General Databook

#### **KEY FEATURES**

- OUTPUT VOLTAGE SET INTERNALLY TO ±1.5% ON SG7900A
- OUTPUT CURRENT TO 1.5A
- EXCELLENT LINE & LOAD REGULATION
- FOLDBACK CURRENT LIMITING
- THERMAL OVERLOAD PROTECTION
- VOLTAGES AVAILABLE: -5V, -5.2V, -6V, -8V, -12V, -15V, -18V, -20V
- CONTACT FACTORY FOR OTHER VOLTAGE OPTIONS

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- MIL-M38510/11501BXA-JAN7905T
- MIL-M38510/11505BYA-JAN7905K
- MIL-M38510/11502BXA-JAN7912T
- MIL-M38510/11506BYA-JAN7912K
- MIL-M38510/11503BXA-JAN7915T
- MIL-M38510/11507BYA-JAN7915K
- SCHEDULED FOR MIL-M-38510 QPL LISTING
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

(See next page for Package Pinouts)

		PACKAGE OR	DER INFORMAT	ION	
T <sub>A</sub> (°C)	TO-3 Metal Can 3-Terminal	R TO-66 Metal Can 3-Terminal	IG TO-257 Hermetic 3-pin (Isolated)	T TO-39 Metal Can 3-pin	L Ceramic LCC 20-pin
0 to 125	SG79xxK	_	_	_	_
-55 to 125	SG79xxAK*	SG79xxAR*	SG79xxAIG*	SG79xxAT*	SG79xxL
MIL-STD-883	SG79xxAK/883B*	SG79xxAR/883B*	SG79xxAIG/883B*	SG79xxAT/883B*	SG79xxL/883B
	JAN7905K	-	-	JAN7905T	-
JAN SPEC.	JAN7912K		_	JAN7912T	_
	JAN7915K		_	JAN7915T	-
	SG7905AK/DESC	SG7905AR/DESC	SG7905AIG/DESC	SG7905AT/DESC	_
DECC	SG7908AK/DESC	SG7908AR/DESC	SG7908AIG/DESC	SG7908AT/DESC	_
DESC	SG7912AK/DESC	SG7912AR/DESC	SG7912AIG/DESC	SG7912AT/DESC	_
	SG7915AK/DESC	SG7915AR/DESC	SG7915AIG/DESC	SG7915AT/DESC	

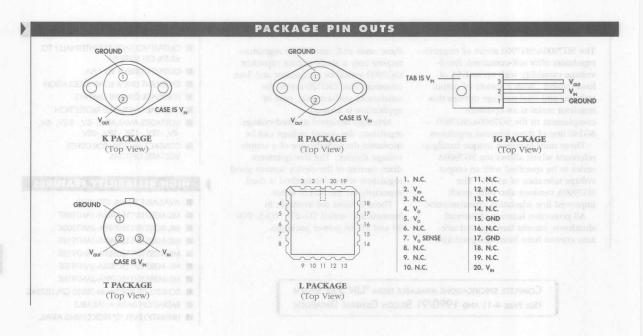
"A" denotes improved performance over the non-"A" version, non-"A" versions also available.

"xx" to be replaced by output voltage of specific fixed regulator.

# SG7900A/SG7900 Series

# NEGATIVE FIXED VOLTAGE REGULATOR

# 248123 Walf and dadw Noto Recommended for New Designs





**SM600** 

## SWITCHING REGULATOR POWER OUTPUT STAGES

THE INFINITE POWER OF INNOVATION

NOT RECOMMENDED FOR NEW DESIGNS

#### DESCRIPTION

The SM600/SM601/SM602 and SM610/SM611/SM612 series of Power Output Stages are especially designed to be driven with standard PWM integrated circuits to form an efficient switching power supply. The SM600, SM601 and SM602 are optimized for non-isolated Buck and Buck-Boost application, where SM610, SM611 and SM612 are

best suited for DC-DC Boost type applications as well as negative output Buck Converters. The hybrid circuit construction utilizes thick film resistors on a beryllia substrate for maximum thermal conductivity and resultant low thermal impedance. All of the active elements in the hybrid are fully passivated.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

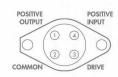
#### KEY FEATURES

- EQUIVALENT TO THE UNITRODE PIC 600, 601, 602, 610, 611, 612
- 5A CURRENT CAPABILITY
- DESIGNED AND CHARACTERIZED FOR SWITCHING REGULATOR APPLICATIONS SUCH AS BUCK, BOOST, AND BUCK-BOOST TYPE
- COST SAVING DESIGN REDUCES SIZE, IMPROVES EFFICIENCY, REDUCES NOISE AND RFI
- HIGH OPERATING EFFICIENCY AT 2A TYPICAL PERFORMANCE:
  - RISE AND FALL TIME < 75ns
  - EFFICIENCY > 85%
- ELECTRICALLY ISOLATED, 4-PIN, TO-66 HERMETIC CASE

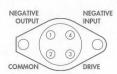
#### HIGH RELIABILITY FEATURES

 AVAILABLE WITH HIGH RELIABILITY PROCESSING

## PACKAGE PIN OUTS



R PACKAGE (Positive Input/Output) (Top View)



R PACKAGE (Negative Input/Output) (Top View)

PACKA	GE ORDER IN	FORMATION
T <sub>A</sub> (°C)	R Metal Can TO-66 4-pin (Positive)	R Metal Can TO-66 4-pin (Negative)
	SM600R	SM610R
0 to 70	SM601R	SM611R
-	SM602R	SM612R
	SM600HRR	SM610HRR
-55 to 125	SM601HRR	SM611HRR
	SM602HRR	SM612HRR

FOR FURTHER INFORMATION CALL (714) 898-8121

# Notes









## SWITCHING REGULATOR POWER OUTPUT STAGES

THE INFINITE POWER OF INNOVATION

NOT RECOMMENDED FOR NEW DESIGNS

#### DESCRIPTION

The SM625/SM626/SM627 series of Power Output Stages are especially designed to be driven with standard PWM integrated circuits to form an efficient switching power supply. The SM625, SM626 and SM627 are optimized for non-isolated Buck and

Buck-Boost application. The hybrid circuit construction utilizes thick film resistors on a beryllia substrate for maximum thermal conductivity and resultant low thermal impedance. All of the active elements in the hybrid are fully passivated.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

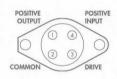
#### KEY FEATURES

- EQUIVALENT TO THE UNITRODE PIC 625, 626, 627
- 15A CURRENT CAPABILITY
- COST SAVING DESIGN REDUCES SIZE, IMPROVES EFFICIENCY, REDUCES NOISE AND RFI
- HIGH OPERATING FREQUENCY (TO > 100KHz) RESULTS IN SMALLER INDUCTOR-CAPACITOR FILTER AND IMPROVED POWER SUPPLY RESPONSE TIME
- HIGH OPERATING EFFICIENCY AT 7A TYPICAL PERFORMANCE:
  - RISE AND FALL TIME < 300ns
  - EFFICIENCY > 85%
- ELECTRICALLY ISOLATED, 4-PIN, TO-66 HERMETIC CASE

#### HIGH RELIABILITY FEATURES

AVAILABLE WITH HIGH RELIABILITY PROCESSING

#### PACKAGE PIN OUTS



R PACKAGE (Top View)

## PACKAGE ORDER INFO

T <sub>A</sub> (°C)	R Metal Can TO-66 4-pin			
	SM625R			
0 to 70	SM626R			
	SM627R			
	SM625HRR			
-55 to 125	SM626HRR			
	SM627HRR			

# Notes

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# DESCRIPTION OF THE PROPERTY OF

- RODIVACENT TO THE UTSTRODE RIC 685
  - # 15A CURRENT CAPABILITY
- W COST SANING DESIGN REDUCES SIZE, INVROVES EFFORMOV, REDUCES HOISE SAND RET
- II HIGH OFBIATING REQUENCY (TO S TORRHAMESULTS IN SWALLER INDUCTOR CARACTOR RUTER AND WINCOVER DOWER
  - # HIGH ORRESTING ETROPINGY AT 7A OPEN AND FAIL TAIR < 2000
  - # ELECTRICALLY ISOLATED, 4-TNL TO-56
    HERMETIC CASE

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M. AVAULABLE WITH HIGH JELFARIUTY PROCESSING Bode boost application, "the hybrid circuit construction utilizes dick him resistant on a beryllar substant for continuum thermal conduction and resultant flow thermal appelance. All

esultant low thermal impedance. All if the writer elements in the firthird are ally massivated The SM625-SM626-SM627 series of Power Output Stages are especially designed to be driven with standard PWM integrated circuits to form an efficient switching power supply. The SM625, SM625 and SM627 are

COMPLETE SPECIFICATIONS ANALYSIS FROM "EIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILKON GENERAL DATASOCIE







SM645

# SWITCHING REGULATOR POWER OUTPUT STAGES

THE INFINITE POWER OF INNOVATION

NOT RECOMMENDED FOR NEW DESIGNS

#### DESCRIPTION

The SM645/SM646/SM647 series of Power Output Stages are especially designed to be driven with standard PWM integrated circuits to form an efficient switching power supply. The SM645, SM646 and SM647 are optimized for non-isolated Buck and

Buck-Boost application. The hybrid circuit construction utilizes thick film resistors on a beryllia substrate for maximum thermal conductivity and resultant low thermal impedance. All of the active elements in the hybrid are fully passivated.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

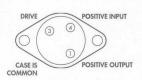
#### KEY FEATURES

- EQUIVALENT TO THE UNITRODE PIC 645, 646 & 647
- 15A CURRENT CAPABILITY
- COST SAVING DESIGN REDUCES SIZE, IMPROVES EFFICIENCY, REDUCES NOISE AND RFI
- HIGH OPERATING FREQUENCY (TO > 100KHz) RESULTS IN SMALLER INDUCTOR-CAPACITOR FILTER AND IMPROVED POWER SUPPLY RESPONSE TIME
- HIGH OPERATING EFFICIENCY AT 7A TYPICAL PERFORMANCE:
  - RISE AND FALL TIME < 300ns
  - EFFICIENCY > 85%

#### HIGH RELIABILITY FEATURES

 AVAILABLE WITH HIGH RELIABILITY PROCESSING

#### PACKAGE PIN OUTS



K PACKAGE (Top View)

#### PACKAGE ORDER INFO

T <sub>A</sub> (°C)	K Metal Can TO-3 4-Terminal			
	SM645K			
0 to 70	SM646K			
	SM647K			
	SM645HRK			
-55 to 125	SM646HRK			
	SM647HRK			

# Notes

tor Recommended for thew Designs

M647 series of Busic-Burst application. The hybrid

lane visitani per derivati nu minera IlA socialisti in interest col ministra me butte a u a como de politica The SMO45/SM646/SM647 series of Power Output Singles are especially feeding to be threen with standard feeding to be threen with standard should be form an efficient witching power supply. The SM640 and SM047 and said for domisolated buck and for domisolated buck and

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIM" FAX SYSTEM

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- B COST SAVING DESIGN PERUCES SIZE, IMPROVES EPROENCY, PERUCES NOISE
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  - B. HIGH OPERATING ETROPHOS AT TA TYRICAL PERCENANCE
- CARUTARA VILLIBAD AN MADIE.
  - # AVAILABLE WITH HIGH RELIABILITY
    PROCESSING

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T<sub>0</sub> (%) \$7% Metal Can TO-3

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O to 70 \$250 \$250 \$500 \$500

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CURRENT MODE PWM CONTROLLER

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

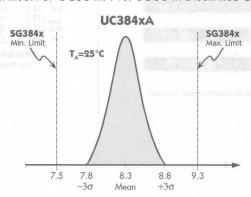
#### DESCRIPTION

The UC184xA family of control ICs provides all the necessary features to implement off-line fixed-frequency, current-mode switching power supplies with a minimum of external components. The current mode architecture demonstrates improved load regulation, pulse-by-pulse current limiting and inherent protection of the power supply output switch. The IC includes: A bandgap reference trimmed to ±1% accuracy, an error amplifier, a current sense comparator with internal clamp to 1V, a high current totem pole output stage for fast switching of power

MOSFET's, and an externally programmable oscillator to set frequency and maximum duty cycle. The undervoltage lock-out is designed to operate with 250µA typ. start-up current, allowing an efficient bootstrap supply voltage design. Available options for this family of products, such as start-up voltage hysteresis and duty cycle, are summarized below in the Available Options section. The UC184xA family of control ICs is also available in 14-pin SOIC package which makes the Power Output Stage Collector and Ground pins available.

## PRODUCT HIGHLIGHT

COMPARISON OF UC384XA VS. SG384X DISCHARGE CURRENT



Discharge Current Distribution - mA

#### KEY FEATURES

- LOW START-UP CURRENT. (0.5mA max.)
- TRIMMED OSCILLATOR DISCHARGE CURRENT. (See Product Highlight)
- OPTIMIZED FOR OFF-LINE AND DC-TO-DC CONVERTERS.
- AUTOMATIC FEED FORWARD COMPENSATION.
- PULSE-BY-PULSE CURRENT LIMITING.
- ENHANCED LOAD RESPONSE CHARACTERISTICS.
- UNDER-VOLTAGE LOCKOUT WITH HYSTERESIS.
- DOUBLE PULSE SUPPRESSION.
- HIGH-CURRENT TOTEM POLE OUTPUT.
- INTERNALLY TRIMMED BANDGAP REFERENCE.
- 500KHz OPERATION.
- LOW R ERROR AMPLIFIER.

## APPLICATIONS

- ECONOMICAL OFF-LINE FLYBACK OR FORWARD CONVERTERS.
- DC-DC BUCK OR BOOST CONVERTERS.
- LOW COST DC MOTOR CONTROL.

#### AVAILABLE OPTIONS

Part # °	Start-Up Voltage	Hysteresis	Max. Duty Cycle
UCx842A	16V	6V	<100%
UCx843A	8.4V	0.8V	<100%
UCx844A	16V	6V	<50%
UCx845A	8.4V	0.8V	<50%

	PACI	(AGE ORDER	INFORMATION	
T <sub>A</sub> (°C)	M Plastic DIP 8-pin	DM Plastic SOIC 8-pin	D Plastic SOIC 14-pin	Y Ceramic DIP 8-pin
0 to 70	UC384xAM	UC384xADM	UC384xAD	_
-40 to 85	UC284xAM	UC284xADM	UC284xAD	UC284xAY
-55 to 125			·	UC184xAY

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. UC3842ADMT)

# CURRENT MODE PWM CONTROLLER

# TRANS ATA O HOLT PRODUCTION DATA SHEET

	A	BSOL	UTE MAXIM	UM RATINGS	(Note 1)		)		PACKAGE	PIN OUTS
Supp Outp Outp Anale Error Powe Stora Lead	by Voltage but Curren but Energy og Inputs r Amp Out er Dissipat age Tempea I Temperat 1. Exceed to Grou	$e (I_{cc} < 30)$ t	OmA)  Dive Load)  Current	kes the Power	ce. All voltages	-0.3V to +6 -0.3V to +6 -0.3V to +15 -0.3V to +15 -0.3V to +15	ing £1A 5µJ .3V mA 1W 0°C	Land Control	V <sub>18</sub> 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	8 V <sub>EEF</sub> 7 V <sub>CC</sub> 6 OUTPUT 5 GND
			THERM	AL DATA				197/3	(Top	View)
-	CKAGE:	STANCE !	UNICTION TO AUDI	ENT 0		95°C/W		17.7.3		
	ACKAGE:	STANCE-J	UNCTION TO AMBI	ENI, H <sub>JA</sub>		95°C/W			N.C.   2	14 V <sub>REF</sub> 13 N.C.
-	-	STANCE-J	UNCTION TO AMBI	ENT, θ <sub>IA</sub>		165°C/W	C .ev A	N.C.L.	V <sub>FB</sub>	12 <b>V</b> <sub>cc</sub>
D PA	CKAGE:	FILE	LEGIS			A	HASEQU		I <sub>SENSE</sub>	10 DUTPUT 9 GND
	P311	STANCE-J	UNCTION TO AMBI	ENT, θ <sub>JA</sub>		120°C/W	0		R <sub>7</sub> /C <sub>7</sub> III 7	8 PWR GND
Particular State of the last o	CKAGE: ERMAL RESI	STANCE-I	UNCTION TO AMBI	FNT. fl		130°C/W	fat ?	TER-T		CKAGE View)
Juncti The 6	ion Temper <sub>IA</sub> numbers	rature Calc	culation: $T_1 = T_A +$	, JA					(TO)	YICW)
<190%										
									-	

Cepimic DIP 44 Septin		



# CURRENT MODE PWM CONTROLLER

## PRODUCTION DATA SHEET

## ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for UC384xA with  $^{\circ}$ C  $\leq$   $T_{A} \leq$  70°C, UC284xA with  $^{-4}$ 0°C  $\leq$   $T_{A} \leq$  85°C, UC184xA with  $^{-5}$ 5°C  $\leq$   $T_{A} \leq$  125°C;  $V_{CC}$ =15V;  $R_{T}$ =10K;  $C_{T}$ =3.3nF. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions		34xA/2			IC384x		Units
Falalletel	Syllioui	rest conditions	Min.	Тур.	Max.	Min.	Тур.	Max.	Office
Reference Section									
Output Voltage	V <sub>REF</sub>	$T_J = 25$ °C, $I_L = 1$ mA	4.95	5.00	5.05	4.90	5.00	5.10	٧
Line Regulation		$12 \le V_{IN} \le 25V$		6	20		6	20	mV
Load Regulation	10 (	1 ≤ I <sub>o</sub> ≤ 20mA	60	6	25	9	6	25	mV
Temperature Stability (Note 2 & 7)	Cax 1	AZVASA		0.2	0.4		0.2	0.4	mV/°C
Total Output Variation		Over Line, Load, and Temperature	4.9		5.1	4.82	way v	5.18	V
Output Noise Voltage (Note 2)	V <sub>N</sub>	10Hz ≤ f ≤ 10kHz, T <sub>J</sub> = 25°C		50		100	50	mn92	μV
Long Term Stability (Note 2)		T <sub>A</sub> = 125°C, t = 1000hrs		5	25		5	25	mV
Output Short Circuit Current	I <sub>sc</sub>		-30	-100	-180	-30	-100	-180	mA
Oscillator Section	oc l	Amago	20			The street		Total Control	Zerren
Initial Accuracy (Note 6)		T <sub>1</sub> = 25°C	47	52	57	47	52	57	kHz
Voltage Stability		$12 \le V_{cc} \le 25V$		0.2	1		0.2	1	%
Temperature Stability (Note 2)		$T_{MIN} \le T_A \le T_{MAX}$	in data the sail	5	ne bes	COLUMN TO	5	201 8	%
Amplitude (Note 2)	= प्रशासित	MIR A MOX		1.7			1.7		٧
Discharge Current		T <sub>1</sub> = 25°C, V <sub>PIN 4</sub> = 2V	7.8	8.3	8.8	7.8	8.3	8.8	mA
are the maximum & minimum referen	m Grini	$V_{PIN 4} = 2V, T_{MIN} \le T_A \le T_{MAX}$	7.5	1	8.8	7.6		8.8	mA
Error Amp Section	of the same of	PIN 4 - 7 MIN - A - MAX	CHOOLS DIVINE	23530 193	UE 5117	years to	B8 /	1000	
Input Voltage	D. SHOPES	V <sub>PIN 1</sub> = 2.5V	2.45	2.50	2.55	2.42	2.50	2.58	V
Input Bias Current	I <sub>B</sub>	PINT		-0.3	-1	Antel	-0.3	-2	μА
Open Loop Gain	A <sub>VOL</sub>	$2 \le V_{\odot} \le 4V$	65	90		65	90		dB
Unity Gain Bandwidth (Note 2)	UGBW	T <sub>i</sub> = 25°C	0.7	1	108	0.7	1	e añ	MHz
Power Supply Rejection Ratio (Note 3)	PSRR	12 ≤ V <sub>cc</sub> ≤ 25V	60	70		60	70	Chip In	dB
Output Sink Current	I <sub>OL</sub>	$V_{PIN.9} = 2.7V, V_{PIN.1} = 1.1V$	2	6	- 8 -	2	6		mA
Output Source Current	I <sub>OH</sub>	V <sub>PIN 9</sub> = 2.3V, V <sub>PIN 1</sub> = 5V	-0.5	-0.8	3	-0.5	-0.8		mA
Output Voltage High Level	V <sub>OH</sub>	$V_{PIN.9} = 2.3V$ , $R_i = 15K$ to ground	5	6	78.	5	6		٧
Output Voltage Low Level	V <sub>OL</sub>	$V_{\text{PIN 9}} = 2.7 \text{V}, R_{\text{i}} = 15 \text{K to } V_{\text{per}}$		0.7	1.1		0.7	1.1	٧
Current Sense Section	I OL	PIN 2 / L REF	all va	-					
Gain (Note 3 & 4)	A <sub>VOL</sub>	- APLACAS	2.85	3	3.15	2.85	3	3.15	V/V
Maximum Input Signal (Note 3)	, VOL	V <sub>PIN 1</sub> = 5V	0.9	1	1.1	0.9	1	1.1	V
Power Supply Rejection Ratio (Note 3)	PSRR	$12 \le V_{CC} \le 25V$	100	70		0.7	70		dB
Input Bias Current	I <sub>B</sub>	12 = 100 = 201		-2	-10		-2	-10	uА
Delay to Output (Note 2)	T <sub>pd</sub>	V <sub>PIN 3</sub> = 0 to 2V		150	300		150	300	ns
Output Section	pd pd	1 PIN 3 - 0 to 21		100	000		100	000	110
Output Low Level	1	L - 00m A	1 10	0.1	0.4		0.1	0.4	V
The state of the s	V <sub>OL</sub>	I <sub>SINK</sub> = 20mA			0.4		0.1		V
Output High Lovel	-	I <sub>SINK</sub> = 200mA	12	1.5	2.2	12	1.5	2.2	V
Output High Level	V <sub>OH</sub>	I <sub>SOURCE</sub> = 20mA	13	13.5	4	13	13.5		V
Disa Time (Note 9)	T	I <sub>SOURCE</sub> = 200mA	12	50	150	12	13.5	150	
Rise Time (Note 2)	T <sub>R</sub>	$T_{J} = 25^{\circ}C, C_{L} = 1 \text{nF}$		50	150		50	150	ns
Fall Time (Note 2)	T <sub>F</sub>	$T_J = 25^{\circ}\text{C}, C_L = 1\text{nF}$		0.7			0.7	1.5.5.	ns V
UVLO Saturation	V <sub>SAT</sub>	$V_{cc} = 5V$ , $I_{SINK} = 10mA$		0.7	1.2		0.7	1.2	٧

(Electrical Characteristics continue next page.)



# CURRENT MODE PWM CONTROLLER

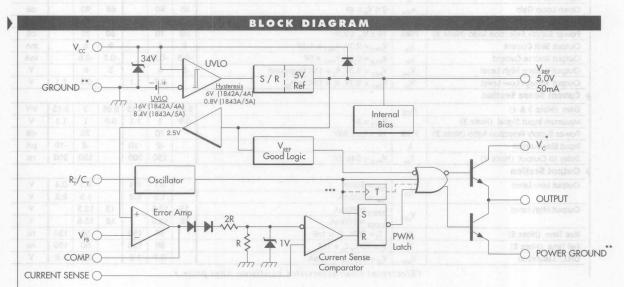
## PRODUCTION DATA SHEET

	ELECT	TRICAL CHARACTERISTICS	(Con't.	)					
Parameter	Cumbal	Test Conditions	UC184xA/284xA			UC384xA			Units
Parameter	Symbol	rest conditions	Min.	Тур.	Max.	Min.	Тур.	Max.	Omic
Under-Voltage Lockout Section									
Start Threshold		x842A/4A	15	16	17	14.5	16	17.5	٧
		x843A/5A	7.8	8.4	9.0	7.8	8.4	9.0	٧
Min. Operation Voltage After Turn-On		x842A/4A	9	10	11	8.5	10	11.5	٧
	4.95	x843A/5A	7.0	7.6	8.2	7.0	7.6	8.2	V
PWM Section		789 2 V 2 3 F		,			no	rolups	Naniu
Maximum Duty Cycle		x842A/3A	94	96	100	94	96	100	%
		x844A/5A	47	48	50	47	48	50	%
Minimum Duty Cycle	The Action				0	ROI	Bhay:	0	%
Total Standby Section		708= 1 at or 217 cm/	at .		(5 250	M) 950	MOV-1	HOM M	diac
Start-Up Current	Let I			0.3	0.5	UCDES)	0.3	0.5	mA
Operating Supply Current	I <sub>cc</sub>		4	11	17	H THEFT Y	11	17	mA
Zener Voltage	V,	$I_{cc} = 25\text{mA}$	30	35		30	35	- OFF	٧

- Notes: 2. These parameters, although guaranteed, are not 100% tested in 7. "Temperature stability, sometimes referred to as average temperature
  - 3. Parameter measured at trip point of latch with  $V_{VFB} = 0$ .
  - 4. Gain defined as:  $\Lambda_{VOL} = \frac{\Delta V_{COMP}}{\Delta V_{ISENSE}}$ ;  $0 \le V_{ISENSE} \le 0.8V$ .
  - 5. Adjust V<sub>cc</sub> above the start threshold before setting at 15V.
  - 6. Output frequency equals oscillator frequency for the UC1842A and UC1843A. Output frequency is one half oscillator frequency for the UC1844A and UC1845A
- coefficient, is described by the equation:

Temp Stability = 
$$\frac{V_{REF} (max.) - V_{REF} (min.)}{T_{J} (max.) - T_{J} (min.)}$$

V<sub>DEF</sub> (max.) & V<sub>DEF</sub> (min.) are the maximum & minimum reference voltage measured over the appropriate temperature range. Note that the extremes in voltage do not necessarily occur at the extremes in temperature."



- \* V<sub>cc</sub> and V<sub>c</sub> are internally connected for 8 pin packages.
- \*\* POWER GROUND and GROUND are internally connected for 8 pin packages.
- \*\*\* Toggle flip flop used only in x844A and x845A series.

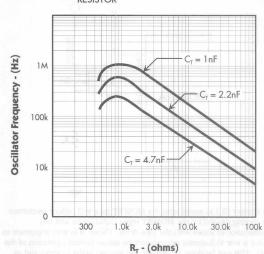


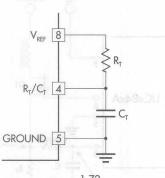
# CURRENT MODE PWM CONTROLLER

# PRODUCTION DATA SHEET

## CHARACTERISTIC CURVES

# FIGURE 1. — OSCILLATOR FREQUENCY vs. TIMING RESISTOR

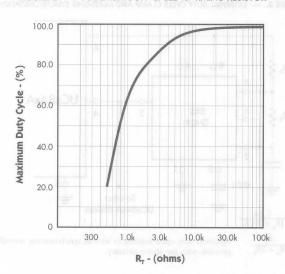




For  $R_T > 5k$ ,  $f \approx \frac{1.72}{R_T C_T}$ 

Note: Output drive frequency is half the oscillator frequency for the UCx844A/5A devices.

#### FIGURE 2. — MAXIMUM DUTY CYCLE vs. TIMING RESISTOR

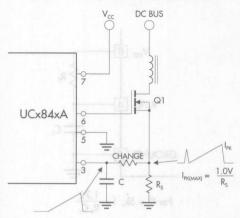


# CURRENT MODE PWM CONTROLLER

# PRODUCTION DATA SHEET

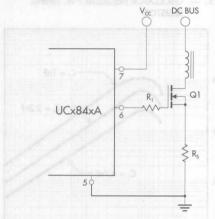
## TYPICAL APPLICATION CIRCUITS

FIGURE 3. — CURRENT SENSE SPIKE SUPPRESSION



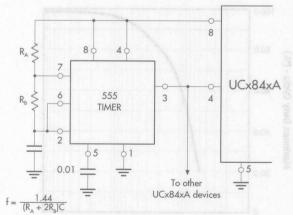
The RC low pass filter will eliminate the leading edge current spike caused by parasitics of Power MOSFET.

FIGURE 4. — MOSFET PARASITIC OSCILLATIONS



A resistor ( $R_i$ ) in series with the MOSFET gate will reduce overshoot & ringing caused by the MOSFET input capacitance and any inductance in series with the gate drive. (Note: It is very important to have a low inductance ground path to insure correct operation of the I.C. This can be done by making the ground paths as short and as wide as possible.)

#### FIGURE 5. — EXTERNAL DUTY CYCLE CLAMP AND MULTI-UNIT SYNCHRONIZATION



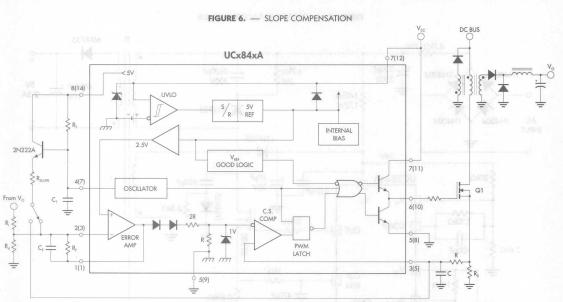
 $f = \frac{R_B}{R_A + 2R_B}$  Precision duty cycle limiting as well as synchronizing several parts is possible with the above circuitry.



# CURRENT MODE PWM CONTROLLER

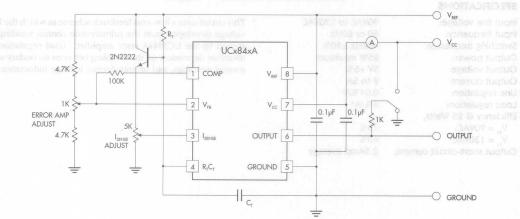
## PRODUCTION DATA SHEET

## TYPICAL APPLICATION CIRCUITS (continued)



Due to inherent instability of current mode converters running above 50% duty cycle, slope compensation should be added to either the current sense pin or the error amplifier. Figure 6 shows a typical slope compensation technique.

#### FIGURE 7. — OPEN LOOP LABORATORY FIXTURE

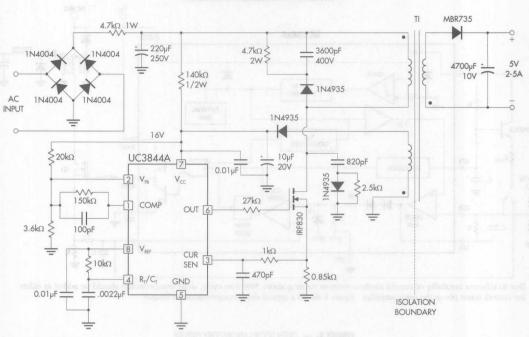


High peak currents associated with capacitive loads necessitate careful grounding techniques. Timing and bypass capacitors should be connected to pin 5 in a single point ground. The transistor and 5k potentiometer are used to sample the oscillator waveform and apply an adjustable ramp to pin 3.



# TYPICAL APPLICATION CIRCUITS (continued)

#### FIGURE 8. — OFF-LINE FLYBACK REGULATOR



#### **SPECIFICATIONS**

Input line voltage:	90VAC to 130VAC
Input frequency:	50 or 60Hz
Switching frequency:	40KHz ±10%
Output power:	25W maximum
Output voltage:	5V +5%
Output current:	2 to 5A
Line regulation:	0.01%/V
Load regulation:	8%/A*
Efficiency @ 25 Watts,	
V <sub>IN</sub> = 90VAC:	70%
V <sub>IN</sub> = 130VAC:	65%
Output short-circuit current:	2.5Amp average

\* This circuit uses a low-cost feedback scheme in which the DC voltage developed from the primary-side control winding is sensed by the UC3844A error amplifier. Load regulation is therefore dependent on the coupling between secondary and control windings, and on transformer leakage inductance.



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**C**LINFINITY

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Bold = New Product, \*Bold Italic = Preliminary



# **Selection Guide**

# DATA COMMUNICATIONS PRODUCTS

# SCSI Terminators

## PERFORMANCE CHARACTERISTICS

DEVICE TYPE		SC 2	SI S1	andard	No. of Channels	Output Capacitance	Active Neg. Compatible	Hot Swap	Supply Current	Logic Enable	n.
LX5212	Page # 7-31	2	3	/	9	2.5pF	у	У	600µА	L	N, PWP DP
LX5218	7-39			1	9	4.0pF	у	N	6.0mA	L	DW, PW
LX5219	7-39			1	9	4.0pF	y	N	6.0mA	Н	DW, PW
LX5207	7-23			1	18	2.5pF	У	У	800µА	L	N, DWP
LX5204	7-19	1	1		9	3.5pF	У	y	600μΑ	L	PWP, DP
LX5107	7-5	1	1		9	ЗрБ	У	У	700µA	Н	DW, PW
LX5203	7-15	1	1		9	6pF	У	N	600µА	L	N, DP
LX5213	7-35	1	1		9	3.5pF	У	И	600μΑ	L	N, PWP DP
LX5202	7-11	1	1		18	6pF	у	N	800μΑ	L	N, DWP
LX5208	7-27	1	1		18	3.5pF	у	И	800µА	L	N, DWP
LX5285	6-81	1	1	1	n/a	n/a	у	n/a	5.0mA	n/a	ST

# SCSI Transceivers

# PERFORMANCE CHARACTERISTICS

DEVICE TYPE	Page #	SCSI Standard	# CHAN Receiver	INELS Driver	Logic	OU Capacitance	TPUT Configuration	PROP. Driver	DELAY Receiver	PACKAGES
LX5268	7-51	2, 3, ULTRA	6	6	Invert.	15pF	Totem-Pole Open-Drain	10ns	10ns	DB
LX5269	7-59	2, 3, ULTRA	6	6	Buffer	15pF	Totem-Pole Open-Drain	10ns	10ns	DB



# Notes



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LX5107

9-Line Low Capacitance, µPower SCSI Terminator

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#### DESCRIPTION

The LX5107 is a nine-line active terminator for the SCSI parallel bus. This SCSI standard recommends active termination at both ends of the SCSI bus.

During disconnect mode, the LX5107 requires a meager 30uA of supply current while offering only 3.0pF of output capacitance. To enter this low-power mode, the disconnect pin should be driven low thereby disconnecting the terminating resistors and placing the internal low dropout regulator into low-power mode. In disconnect mode, each termination line presents a high impedance to the SCSI bus with the overall effect being to preserve high signal integrity and yield subsequent reliable, error free communications.

During normal operation, the LX5107 consumes only 600µA of current which is

the lowest enabled supply current of any terminator available on the market today. Linfinity's proprietary BiCMOS low dropout regulator architecture enables this unique and very efficient operating characteristic.

The LX5107 also offers a precisely trimmed channel output current specified to a 5% tolerance. The maximum value of the output current is trimmed as closely as possible to the SCSI standard maximum specification to give the highest possible noise margin for fast SCSI operation. In addition, the LX5107 sinks up to 50mA of current making it compatible with today's fast active negation drivers.

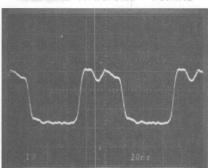
The LX5107 is a superior, pin-for-pin replacement for a variety of industry products such as the DS2107S and DS21S07A.

#### KEY FEATURES

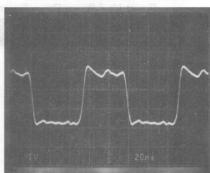
- 3.0pF OUTPUT CAPACITANCE DURING DISCONNECT
- 30µA SUPPLY CURRENT IN DISCONNECT
- 600µA SUPPLY CURRENT DURING NORMAL OPERATION
- 50mA SINK CURRENT FOR ACTIVE NEGATION
- LOGIC COMMAND DISCONNECTS ALL TERMINATION LINES
- CURRENT LIMIT AND THERMAL PROTECTION
- COMPATIBLE WITH SCSI 1, 2 AND 3 STANDARDS
- MEETS SCSI HOT PLUGGING CAPABILITY
- CONSULT FACTORY FOR APPLICATION TEST REPORT: 5107TR

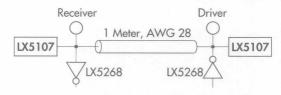
# PRODUCT HIGHLIGHT

RECEIVING WAVEFORM - 10MHz



DRIVING WAVEFORM - 10MHz





#### ORDER INFORMATION DW Plastic SOWB PWP Plastic TSSOP T, (°C) 16-pin 20-pin, Power 0 to 125 LX5107CDW LX5107CPWP

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5107CDWT)

NOTE: -For An In-Depth Discussion On Applying SCSI, Request Linfinity Application Note: "Understanding The Single-Ended SCSI Bus"

#### FOR FURTHER INFORMATION CALL (714) 898-8121

# LX5107

# 9-LINE LOW CAPACITANCE, µPower SCSI TERMINATOR

# THERE AND THE PRODUCTION DATA SHEET AND ASK OF ASSESSED AND

# 

respect to Ground. Currents are positive into, negative out of the specified terminal.

#### THERMAL DATA

#### DW PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{\mathrm{JA}}}$	95°C/W
PWP PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ,	83°C/W

Junction Temperature Calculation:  $T_1 = T_A + (P_D \times \theta_{IA})$ .

The  $\theta_{J_A}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

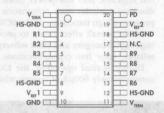
# POWER UP / POWER DOWN FUNCTION TABLE

Disconnect	Outputs	Quiescent Current
L	HIZ	30µА
Н	Enabled	600µA
Open	Enabled	600µA

# PACKAGE PIN OUTS

VTERA		1	16	PD
R1		2	15	V <sub>REF</sub> 2
R2	2	3	14	N.C.
R3		4	13	R9
R4		5	12	R8
R.S		6	11	R7
V <sub>REF</sub> 1		7	10	R6
GNE		8	9	VTERM

# **DW PACKAGE** (Top View)



PWP PACKAGE (Top View)



# 9-Line Low Capacitance, µPower SCSI Terminator

# PRODUCTION DATA SHEET

RECOMMENDED OPE	RATING C	ONDITION	<b>S</b> (Note 2)		
Parameter	Sumbol	Recommen	ded Operating	Conditions	Units
Parameter	Symbol	Min.	Тур.	Max.	Units
TermPwr Voltage	V <sub>TERM</sub>	4	MARK	5.25	V
Signal Line Voltage		0	Largery States	5	٧
Disconnect Input Voltage		0	FICHOLERA	V <sub>TERM</sub>	V
Output Capacitor on V <sub>REF</sub>		2.2			μF
Operating Virtual Junction Temperature Range	3				
LX5107C SWIMMED AN EDATION TURNOG		0		125	°C

Note 2. Range over which the device is functional.

## ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperature range of  $0^{\circ}\text{C} \leq T_{A} \leq 70^{\circ}\text{C}$ . TermPwr = 4.75V, Disconnect = Open. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions		LX5107		Units
raidilletei	Sylliooi	lest collations	Min.	Тур.	Max.	Onne
<b>Supply Current Section</b>						
TermPwr Supply Current		All term lines = Open	Y	0.6	1.2	mA
		All term lines = 0.5V	779	194	210	mA
Power Down Mode		Disconnect = Low		30	70	μA
<b>Output Section (Terminator Lin</b>	ies)					
Terminator Impedance	THE REST	I <sub>TERM</sub> = -5mA to -15mA, T <sub>A</sub> = 25°C	105	110	115	Ω
		I <sub>TERM</sub> = -5mA to -15mA	100	110	120	Ω
Terminator Output High Voltage			2.6	2.9		٧
Max. Output Current		V <sub>out</sub> = 0.5V, T <sub>A</sub> = 25°C	-20.3	-21.8	-23	mA
		$V_{OUT} = 0.5V, 0^{\circ}C \le T_{A} \le 70^{\circ}C$	-19.0	-21.8	-23	mA
		V <sub>OUT</sub> = 0.5V, V <sub>TERM</sub> = 4V, T <sub>A</sub> = 25°C	-19.5	-21.8	-23	mA
	7 (%)	$V_{OUT} = 0.5V$ , $V_{TERM} = 4V$ , $0^{\circ}C \le T_{A} \le 70^{\circ}C$	-18.0	-21.8	-23	mA
Output Leakage		Disconnect = Low, V <sub>OUT</sub> = 0V to 4.0V	118.11.22	10	400	nA
Output Capacitance	11	Disconnect = Low		3.0		pF
Sink Current		V <sub>OUT</sub> = 4V	30	50		mA
Regulator Section						
Regulator Output Voltage	V <sub>REF</sub>			3.6		٧
Line Regulation		V <sub>TERM</sub> = 4V to 6V		10	20	mV
Load Regulation		I <sub>REG</sub> = 0 to -50mA	119,74	20	50	m۷
Drop Out Voltage		$I_{REG} = -50 \text{mA}$		0.7	1.0	٧
Short Circuit Current		V <sub>REG</sub> = OV		-425	-600	mA
Thermal Shutdown				150		°C
Disconnect Section				11.00		
Disconnect Threshold			0.8	1.4	2.0	٧
Input Current		Disconnect = 0V			65	μА

# LX5107

# 9-Line Low Capacitance, µPower SCSI Terminator

# PRODUCTION DATA SHEET

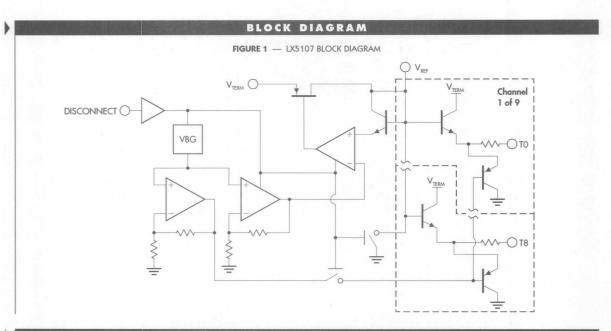
I / CURVE INDEX	GRAPH		E INDEX	FIGUR			
acteristic Curves	Char	5	ion Circu	plicat	Ар	IRE #	FIGU
OUTPUT VOLTAGE TERMPWR RRENT vs. TEMPERATURE OUTPUT VOLTAGE OUTPUT LINE (OUTPUT MATCHING)	4. OUTPUT VOLTAGE vs. 5. OUTPUT CURRENT vs. 6. OUTPUT CURRENT vs. 7. OUTPUT VOLTAGE vs. 8. TERMPWR SUPPLY CUI 9. OUTPUT LEAKAGE vs. 10. OUTPUT CURRENT vs. 11. OUTPUT VOLTAGE vs.	gam sulverinar ingelere preside preside presidente pres	ATION	A APPLICA	SYSTEM 201 201 201 201 201 201 201 201 201 201		2.
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# LX5107

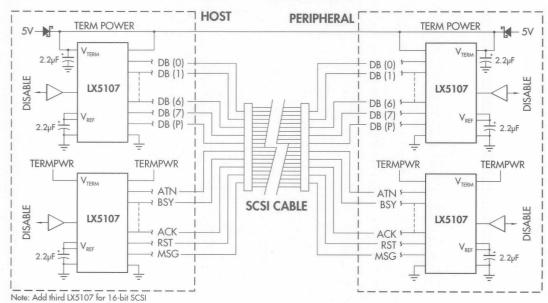
# 9-Line Low Capacitance, µPower SCSI Terminator

# PRODUCTION DATA SHEET



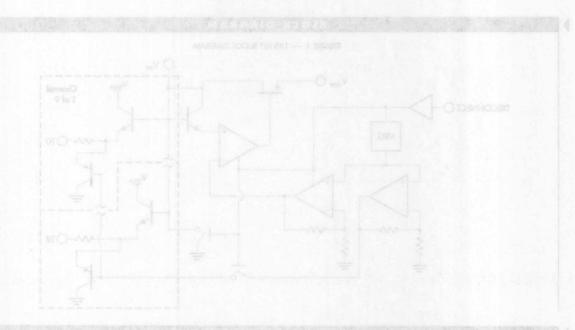
#### APPLICATION SCHEMATIC

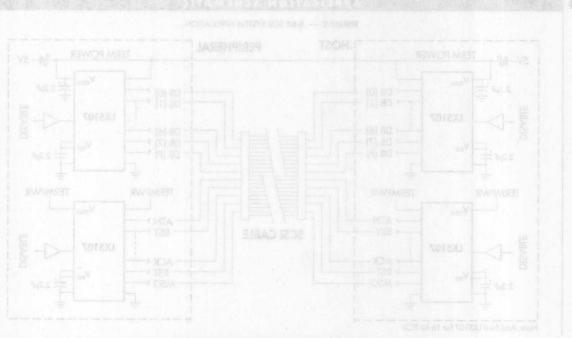
FIGURE 2 — 8-BIT SCSI SYSTEM APPLICATION



# Notes

PRODUCTION DATA SHEET











# 18-Line, µPower SCSI Terminator

THE INFINITE POWER OF INNOVATION PRODUCTION DATA SHEET

#### DESCRIPTION

The LX5202 is an eighteen-line active terminator for the SCSI parallel bus. This SCSI standard recommends active termination at both ends of the SCSI bus.

During disconnect mode, the LX5202 requires a meager 60uA of supply current while offering only 6pF of output capacitance. To enter this low-power mode, the disconnect pin can be left open (floating) or driven high, thereby disconnecting the terminating resistors and placing the internal low dropout regulator into low-power mode. In disconnect mode, each termination line presents a high impedance to the SCSI bus with the overall effect being to preserve high signal integrity and yield subsequent reliable, errorfree communications.

During normal operation, the LX5202 con-

sumes only 800µA of current, which is the lowest enabled supply current of any terminator available on the market today. Linfinity's proprietary BiCMOS low dropout regulator architecture enables this unique and very efficient operating characteristic.

The LX5202 also offers a precisely trimmed channel output current specified to a 5% tolerance. The maximum value of the output current is trimmed as closely as possible to the SCSI standard maximum specification to give the highest possible noise margin for fast SCSI operation. And the LX5202 sinks up to 200mA of current making it compatible with today's fast active negation drivers.

The LX5202 is a superior, pin-for-pin replacement for a variety of industry products such as the UC5601 and UC5602.

#### KEY FEATURES

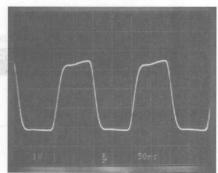
- 6pF OUTPUT CAPACITANCE DURING DISCONNECT
- 60µA SUPPLY CURRENT IN DISCON-NECT MODE
- 800µA SUPPLY CURRENT DURING NORMAL OPERATION
- 200mA SINK CURRENT FOR ACTIVE **NEGATION**
- LOGIC COMMAND DISCONNECTS ALL TERMINATION LINES
- CURRENT LIMIT AND THERMAL PROTECTION
- COMPATIBLE WITH SCSI 1, 2 AND 3 **STANDARDS**
- CONSULT FACTORY FOR APPLICATION TEST REPORT: 5202TR

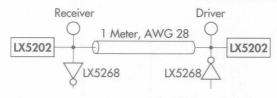
## PRODUCT HIGHLIGHT

RECEIVING WAVEFORM - 5MHz



DRIVING WAVEFORM - 5MHz





PACKAGE ORDER INFORMATION

SAMPLING ONLY DWP Plastic SOWB Plastic DIP TA (°C) 24-pin 28-pin, Power LX5202CN 0 to 70 LX5202CDWP

Note: All surface-mount packages are available in Tape & Reel Append the letter "T" to part number. (i.e. LX5202CDWPT)

- NOTE: -For An In-Depth Discussion On Applying SCSI, Request Linfinity Application Note: "Understanding The Single-Ended SCSI Bus"

#### FOR FURTHER INFORMATION CALL (714) 898-8121

## 18-LINE, µPower SCSI TERMINATOR

#### THE ATAC MONT PRODUCTION DATA SHEET

# ABSOLUTE MAXIMUM RATINGS (Note 1) TermPwr Voltage +7V Signal Line Voltage 0V to +7V Regulator Output Current 1.2A Operating Junction Temperature Plastic (N, DWP Packages) 150°C Storage Temperature Range -65°C to 150°C

#### THERMAL DATA

#### N DACKAGE

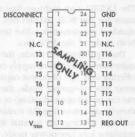
N PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	52°C/W
DWP PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO LEADS, $\theta_{_{\rm I\! I}}$	18°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	40°C/W

Junction Temperature Calculation:  $T_J = T_A + (P_D \times \theta_{JA})$ . The  $\theta_{JA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

#### POWER UP / POWER DOWN FUNCTION TABLE

Disconnect	Outputs	Quiescent Current
L	Enabled	800µА
Н	HIZ	60µA
Open	HIZ	60µA

#### PACKAGE PIN OUTS



N PACKAGE (Top View)



**DWP PACKAGE** (Top View)

# 18-LINE, µPower SCSI TERMINATOR

#### PRODUCTION DATA SHEET

RECOMMENDED OPERATING CONDITIONS (Note 2)						
Parameter	Sumbal		Recommended Operating Conditions			
Faralleter	Symbol	Min.	Тур.	Max.	Units	
TermPwr Voltage	V <sub>TERM</sub>	4		5.25	٧	
Signal Line Voltage	1 1 1	0		5	٧	
Disconnect Input Voltage		0		V <sub>TERM</sub>	٧	
Output Capacitance on REGOUT		4.7		I SEMMOUS O	μF	
Operating Virtual Junction Temperature Range						
LX5202C		0	V	125	°C	

# ELECTRICAL CHARACTERISTICS

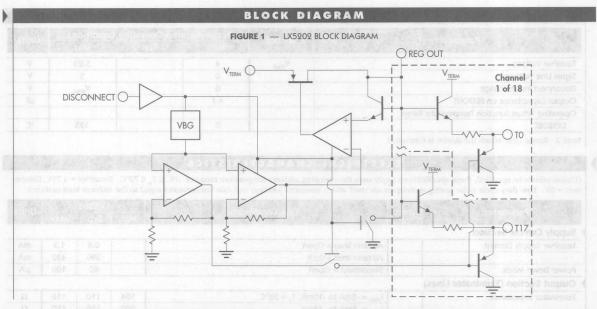
(Unless otherwise specified, these specifications apply over the operating ambient temperature range of  $0^{\circ}C \le T_A \le 70^{\circ}C$ . TermPwr = 4.75V, Disconnect = 0V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

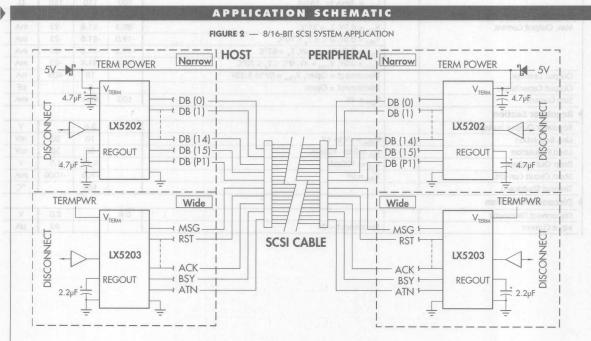
Parameter	Cumbal	Test Conditions		LX5202		Unit
Faranteter	Symbol	rest conditions	Min.	Тур.	Max.	Unit
Supply Current Section						
TermPwr Supply Current		All term lines = Open		0.8	1.5	mA
		All term lines = 0.5V		390	430	mA
Power Down Mode		Disconnect = Open		60	100	μΑ
<b>Output Section (Terminator Line</b>	es)					
Terminator Impedance		I <sub>TERM</sub> = -5mA to -15mA, T <sub>A</sub> = 25°C	104	110	116	Ω
		I <sub>TERM</sub> = -5mA to -15mA	100	110	120	Ω
Terminator Output High Voltage			2.65	2.9		٧
Max. Output Current		$V_{OUT} = 0.5V, T_A = 25^{\circ}C$	-20.3	-21.8	-23	m/
		$V_{OUT} = 0.5V, 0^{\circ}C \le T_A \le 70^{\circ}C$	-19.0	-21.8	-23	mA
		$V_{OUT} = 0.5V, V_{TERM} = 4V, T_A = 25^{\circ}C$	-19.5	-21.8	-23	m/
	wa ank	$V_{OUT} = 0.5V$ , $V_{TERM} = 4V$ , $0^{\circ}C \le T_{A} \le 70^{\circ}C$	-18.0	-21.8	-23	m/A
Output Leakage		Disconnect = Open, V <sub>TERM</sub> = 0V to 5.25V		10	400	nA
Output Capacitance		Disconnect = Open		6		pF
Sink Current	(6) 80	V <sub>OUT</sub> = 4V	100	200	4.7	mA
Regulator Section	1 (1) 40	D8 (1)	* TO 1	170	T.	
Regulator Output Voltage			0(5202	3.6	11 8	٧
Line Regulation	- (A.E) 30	V <sub>TERM</sub> = 4V to 6V	Section 1	10	20	m۷
Load Regulation	-112 (1 SE	$I_{REG} = 0 \text{ to } -100\text{mA}$	SCOUT PERSON	20	50	m۷
Drop Out Voltage	(14) 00	$I_{REG} = -100 \text{mA}$		0.45	1.0	V
Short Circuit Current		$V_{REG} = 0V$		-700	-1000	m/
Thermal Shutdown				150		°C
Disconnect Section	l abaw	I Made I I about		PWR	VURST	
Disconnect Threshold			0.8		2.0	٧
Input Current	- 5200	Disconnect = 0V			40	μА

Note 2. Range over which the device is functional.

# 18-Line, pPower SCSI Terminator

#### PRODUCTION DATA SHEET











#### 9-LINE SCSI ACTIVE TERMINATOR

THE INFINITE POWER OF INNOVATION AS PRODUCTION DATA SHEET

#### DESCRIPTION

The LX5203 is a nine-line active terminator for the SCSI parallel bus. This SCSI standard recommends active termination at both ends of the SCSI bus.

During disconnect mode, the LX5203 requires a meager 60µA of supply current, while offering only 6pF of output capacitance. To enter this low-power mode, the disconnect pin can be left open (floating) or driven high, thereby disconnecting the terminating resistors and placing the internal low dropout regulator into low-power mode. In disconnect mode each termination line presents a high impedance to the SCSI bus with the overall effect being to preserve high signal integrity and yield subsequent reliable, error-free communications.

During normal operation, the LX5203 con-

sumes only 600µA of current. Linfinity's proprietary BiCMOS low dropout regulator architecture enables oscillation-free operation with minimal output capacitance. Linfinity recommends a minimum stabilization capacitor value of 2.2uF.

The LX5203 also offers a precisely trimmed channel output current specified to a 5% tolerance. The maximum value of the output current is trimmed as closely as possible to the SCSI standard maximum specification to give the highest possible noise margin for fast SCSI operation. And the LX5203 sinks up to 150mA of current making it compatible with today's fast active negation drivers.

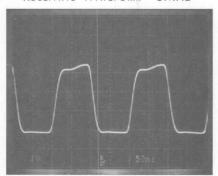
The LX5203 is a superior, pin-for-pin replacement for a variety of industry products such as the UC5603 and UC5613.

#### KEY FEATURES

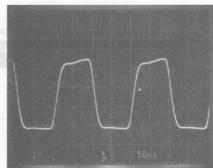
- 6pF OUTPUT CAPACITANCE DURING DISCONNECT
- 60µA SUPPLY CURRENT IN DISCON-NECT MODE
- 600µA SUPPLY CURRENT DURING NORMAL OPERATION
- 150mA SINK CURRENT FOR ACTIVE NEGATION
- LOGIC COMMAND DISCONNECTS ALL TERMINATION LINES
- CURRENT LIMIT AND THERMAL PROTECTION
- COMPATIBLE WITH SCSI 1, 2 AND 3 STANDARDS
- CONSULT FACTORY FOR APPLICATION TEST REPORT: 5203TR

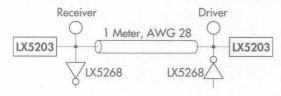
#### PRODUCT HIGHLIGHT

RECEIVING WAVEFORM - 5MHz



DRIVING WAVEFORM - 5MHZ





PACKAGE ORDER INFORMATION

Plastic DIP Plastic SOIC TA (°C) 16-pin, Power 16-pin 0 to 70 LX5203CN LX5203CDP

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5203CDPT)

NOTE: For An In-Depth Discussion On Applying SCSI, Request Linfinity Application Note: "Understanding The Single-Ended SCSI Bus"

FOR FURTHER INFORMATION CALL (714) 898-8121

#### 9-LINE SCSI ACTIVE TERMINATOR

# TERR 2 ATA G ROTPRODUCTION DATA SHEET & REWORD STREET

#### ABSOLUTE MAXIMUM RATINGS (Note 1)

TermPwr Voltage	+7V
Control of the contro	
Regulator Output Current	
Operating Junction Temperature	
Plastic (N, DP Packages)	150°C
Storage Temperature Range	-65°C to 150°C
Lead Temperature (Soldering, 10 second	nds)

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

#### THERMAL DATA

#### N PACKAGE

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ,	65°C/W
DB BACKAGE.	winest for a variety
THERMAL RESISTANCE-JUNCTION TO LEADS, $\theta_{_{\rm IL}}$	20°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	45°C/W

Junction Temperature Calculation:  $T_1 = T_A + (P_D \times \theta_A)$ .

The  $\theta_{j_A}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

#### POWER UP / POWER DOWN FUNCTION TABLE

Disconnect	Outputs	Quiescent Current
L	Enabled	600µA
Н	HIZ	60µА
Open	HIZ	60µA

#### PACKAGE PIN OUTS



#### N PACKAGE (Top View)



#### DP PACKAGE

(Top View)

C LINFINITY

#### 9-LINE SCSI ACTIVE TERMINATOR

#### PRODUCTION DATA SHEET

	Combal	Recommen	ded Operatin	g Conditions	Units
Parameter	Symbol	Min.	Тур.	Max.	Units
TermPwr Voltage	V <sub>TERM</sub>	4		5.25	V
Signal Line Voltage		0		5	V
Disconnect Input Voltage		0		V <sub>TERM</sub>	V
Output Capacitor on REGOUT		2.2		DEMNOUSED	μF
Operating Virtual Junction Temperature Range					
LX5203C		0		125	°C

Note 2. Range over which the device is functional.

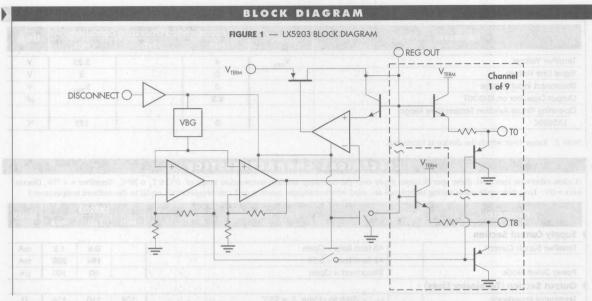
#### **ELECTRICAL CHARACTERISTICS**

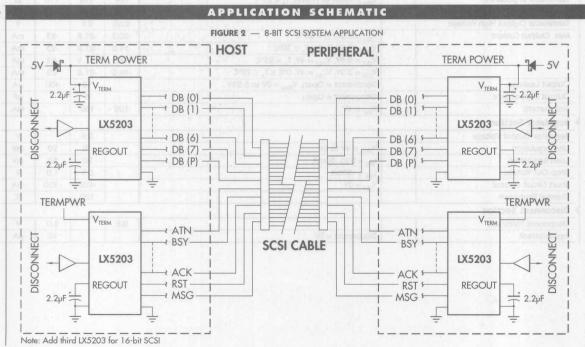
(Unless otherwise specified, these specifications apply over the operating ambient temperature range of  $0^{\circ}\text{C} \leq \text{T}_{A} \leq 70^{\circ}\text{C}$ . TermPwr = 4.75V, Disconnect = 0V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions		LX5203		Unit
Faidilletei	Sylliooi	lest conditions	Min.	Тур.	Max.	Onne
Supply Current Section						
TermPwr Supply Current		All term lines = Open		0.6	1.2	mA
		All term lines = 0.5V		194	208	mA
Power Down Mode		Disconnect = Open		60	100	μА
<b>Output Section (Terminator Line</b>	es)					
Terminator Impedance		$I_{TERM} = -5$ mA to $-15$ mA, $T_A = 25$ °C	104	110	116	Ω
		I <sub>TERM</sub> = -5mA to -15mA	100	110	120	Ω
Terminator Output High Voltage			2.65	2.9		٧
Max. Output Current		$V_{OUT} = 0.5V, T_A = 25^{\circ}C$	-20.3	-21.8	-23	mA
		$V_{OUT} = 0.5V, 0^{\circ}C \le T_A \le 70^{\circ}C$	-19.0	-21.8	-23	mA
		$V_{OUT} = 0.5V$ , $V_{TERM} = 4V$ , $T_A = 25$ °C	-19.5	-21.8	-23	mA
		$V_{OUT} = 0.5V, V_{TERM} = 4V, 0^{\circ}C \le T_A \le 70^{\circ}C$	-18.0	-21.8	-23	mA
Output Leakage		Disconnect = Open, V <sub>TERM</sub> = 0V to 5.25V		10	400	nA
Output Capacitance	→ loi na -	Disconnect = Open	H-H	6		pF
Sink Current	7 11 80 -	V <sub>OUT</sub> = 4V	100	150		mA
Regulator Section			5203	0	7	9 1
Regulator Output Voltage	-F-X(1-00)		San	3.6	N I	V
Line Regulation	H TIRCH	V <sub>TERM</sub> = 4V to 6V	the next	10	20	mV
Load Regulation	1 191.80	I <sub>REG</sub> = 0 to -50mA	Samuel	20	50	mV
Drop Out Voltage		$I_{REG} = -50 \text{mA}$		0.7	1.0	٧
Short Circuit Current		$V_{REG} = OV$		-200	-350	mA
Thermal Shutdown				150	er a union	°C
Disconnect Section					THE SERVICE	
Disconnect Threshold			0.8	100 7	2.0	V
Input Current	1 1/11/4, ***	Disconnect = 0V			40	ЦΑ

#### 9-LINE SCSI ACTIVE TERMINATOR

#### PRODUCTION DATA SHEET











9-LINE HOT SWAP, µPOWER SCSI TERMINATOR

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

The LX5204 is a nine-line active terminator for the SCSI parallel bus. This SCSI standard recommends active termination at both the lowest enabled supply current of any ends of the SCSI bus. The LX5204 has the added features of hot swappability, fully complying with the SCSI hot swap speci-

During disconnect mode, the LX5204 requires a meager 60µA of supply current while offering only 3.5pF of output capacitance. To enter this low-power mode, the disconnect pin can be left open (floating) or driven high, thereby disconnecting the terminating resistors and placing the internal low dropout regulator into low-power mode. In disconnect mode, each termination line presents a high impedance to the SCSI bus with the overall effect being to preserve high-signal integrity and yield subsequent reliable, error-free communications.

During normal operation, the LX5204 consumes only 600µA of current, which is terminator available on the market today. Linfinity's proprietary BiCMOS low dropout regulator architecture enables this unique and very efficient operating characteristic.

The LX5204 also offers a precisely trimmed channel output current specified to a 5% tolerance. The maximum value of the output current is trimmed as closely as possible to the SCSI standard maximum specification to give the highest possible noise margin for fast SCSI operation. And the LX5204 sinks up to 150mA of current, making it compatible with today's fast active negation drivers.

The LX5204 is a superior, pin-for-pin replacement for a variety of industry products such as the UC5603 and UC5613.

#### KEY FEATURES

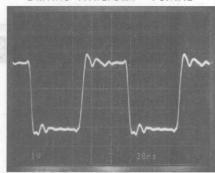
- 3.5pf OUTPUT CAPACITANCE DURING DISCONNECT
- HOT SWAP COMPATIBLE
- 60µA SUPPLY CURRENT IN DISCON-NECT MODE
- 600µA SUPPLY CURRENT DURING NORMAL OPERATION
- 150mA SINK CURRENT FOR ACTIVE NEGATION
- LOGIC COMMAND DISCONNECTS ALL TERMINATION LINES
- CURRENT LIMIT AND THERMAL PROTECTION
- COMPATIBLE WITH SCSI 1, 2 AND 3 STANDARDS
- CONSULT FACTORY FOR APPLICATION TEST REPORT: 5204TR

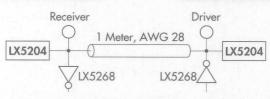
#### PRODUCT HIGHLIGHT

RECEIVING WAVEFORM - 10MHz



DRIVING WAVEFORM - 10MHz





NOTE: For An In-Depth Discussion On Applying SCSI, Request Linfinity Application Note: "Understanding The Single-Ended SCSI Bus"

#### PACKAGE ORDER INFORMATION DP Plastic SOIC Plastic TSSOP TA (°C) 24-pin, Power 16-pin, Power 0 to 70 LX5204CPWP LX5204CDP

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5204CDPT)

FOR FURTHER INFORMATION CALL (714) 898-8121

#### 9-Line Hot Swap, µPower SCSI Terminator

#### PRODUCTION DATA SHEET

#### 

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

#### THERMAL DATA

#### PWP PACKAGE:

THERMAL RESISTANCE-JUNCTION TO LEADS, $ heta_{_{ m I}}$	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{\mathrm{JA}}}$	
DP PACKAGE: WE THOUGHT TO THE	MUESKI SHIT
THERMAL RESISTANCE-JUNCTION TO LEADS, $\theta_{jL}$	20°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ,	45°C/W

Junction Temperature Calculation:  $T_j = T_A + (P_D \times \theta_{jA})$ . The  $\theta_{jA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

#### Power Up / Power Down Function Table

Disconnect	Outputs	Quiescent Current
L	Enabled	600µА
Н	HIZ	60µA
Open	HIZ	60µA

# PACKAGE PIN OUTS



# PWP PACKAGE (Top View)



**DP PACKAGE** (Top View)



# 9-LINE HOT SWAP, µPOWER SCSI TERMINATOR

# PRODUCTION DATA SHEET

	CREDITING CONDIES	ANIC OF THE
RECOMMENDED	OPERATING CONDITION	ON 5 (Note 2)

Parameter	Symbol		Recommen	Units		
Parameter		Symbol	Min.	Тур.	Max.	Units
TermPwr Voltage		V <sub>TERM</sub>	4		5.25	V
Signal Line Voltage			0		5	V
Disconnect Input Voltage			0		V <sub>TERM</sub>	V
Output Capacitor on REGOUT	D.	1 4 1 2	2.2	-<	DISCONNECT	μF
Operating Virtual Junction Temperature Range	1					
LX5204C	10-10		0	rv I	125	°C

Note 2. Range over which the device is functional.

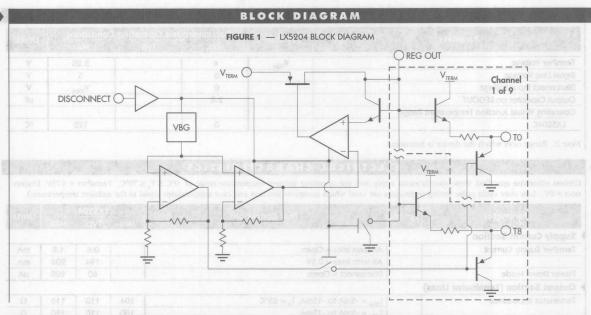
#### **ELECTRICAL CHARACTERISTICS**

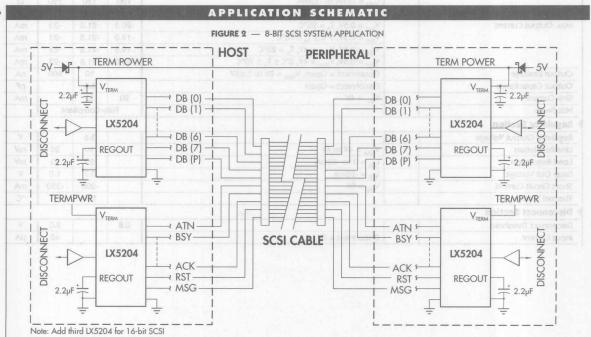
(Unless otherwise specified, these specifications apply over the operating ambient temperature range of  $0^{\circ}$ C  $\leq T_{\Lambda} \leq 70^{\circ}$ C. TermPwr = 4.75V, Disconnect = 0V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions	Test Conditions		LX5204		Unit
raidilletei	Sylliooi	Test Collations		Min.	Тур.	Max.	Oilli
Supply Current Section							
TermPwr Supply Current		All term lines = Open		O State	0.6	1.2	mA
		All term lines = 0.5V		7	194	208	mA
Power Down Mode		Disconnect = Open			60	100	μA
Output Section (Terminator Line	s)						
Terminator Impedance		I <sub>TERM</sub> = -5mA to -15mA, T <sub>A</sub> = 25°C		104	110	116	Ω
		I <sub>TERM</sub> = -5mA to -15mA		100	110	120	Ω
Terminator Output High Voltage		BYAMBHOL NO 14 21 15 1		2.65	2.9		٧
Max. Output Current		V <sub>OUT</sub> = 0.5V, T <sub>A</sub> = 25°C		-20.3	-21.8	-23	mA
		$V_{OUT} = 0.5V, 0^{\circ}C \le T_A \le 70^{\circ}C$	HALL THE	-19.0	-21.8	-23	mA
		V <sub>OUT</sub> = 0.5V, V <sub>TERM</sub> = 4V, T <sub>A</sub> = 25°C		-19.5	-21.8	-23	mA
		$V_{OUT} = 0.5V, V_{TERM} = 4V, 0^{\circ}C \le T_A \le 70^{\circ}C$	I delicate at	-18.0	-21.8	-23	mA
Output Leakage		Disconnect = Open, V <sub>TERM</sub> = 0V to 5.25V	12		10	400	nA
Output Capacitance		Disconnect = Open		100	3.5		pF
Sink Current	(0) 80	V <sub>OUT</sub> = 4V	I- (0) (IC)	20	30	Carlo -	mA
Hot Swap	11180		1- [1] 80 + 1	Ful	ly Compli	ant	
Regulator Section				X520A		一里	
Regulator Output Voltage	- (8) 80		(8) 8G	-	3.6	N 8	٧
Line Regulation	1 (7) 80	V <sub>TERM</sub> = 4V to 6V	- (X) 80 · -	TUDE	10	20	mV
Load Regulation	9 (9) 80	I <sub>REG</sub> = 0 to -50mA	- 191,80		20	50	mV
Drop Out Voltage		I <sub>REG</sub> = -50mA		There	0.7	1.0	٧
Short Circuit Current		V <sub>REG</sub> = OV			-200	-350	mA
Thermal Shutdown					150	MARIET	°C
Disconnect Section					VI		
Disconnect Threshold	- Ulta-		I MA	0.8		2.0	V
Input Current	- V28 -	Disconnect = 0V	Y28	4		40	ЦΑ

# 9-LINE HOT SWAP, µPOWER SCSI TERMINATOR

#### PRODUCTION DATA SHEET











THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

The LX5207 is an eighteen line active terminator for the SCSI parallel bus. This SCSI standard recommends active termination at both ends of the SCSI bus.

During disconnect mode, the LX5207 requires a meager 500nA of supply current while offering only 2.5pF of output capacitance. To enter this low power mode, the disconnect pin can be left open (floating) or driven high thereby disconnecting the terminating resistors and placing the internal low dropout regulator into low power mode. In disconnect mode each termination line presents a high impedance to the SCSI bus with the overall effect being to preserve high signal integrity and subsequent reliable, error free communications.

During normal operation, the LX5207 consumes only 800uA of current which is

the lowest enabled supply current of any terminator available on the market today. Linfinity's proprietary BiCMOS low dropout regulator architecture enables this unique and very efficient operating characteristic.

The LX5207 also offers a precisely trimmed channel output current specified to a 5% tolerance. The maximum value of the output current is trimmed as closely as possible to the SCSI standard maximum specification to give the highest possible noise margin for fast SCSI operation. And finally, the LX5207 sinks up to 100mA of current making it compatible with today's fast active negation drivers.

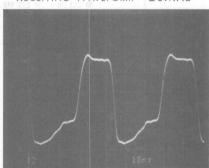
The LX5207 is a superior, pin-for-pin replacement for a variety of industry products such as the UC5601, UC5602, UC5608, and UC5609.

#### KEY FEATURES

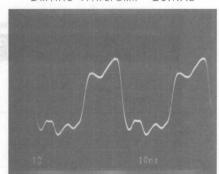
- 2.5pf OUTPUT CAPACITANCE DURING DISCONNECT
- 500nA SUPPLY CURRENT IN DISCONNECT MODE
- 800µA SUPPLY CURRENT DURING NORMAL OPERATION
- 100mA SINK CURRENT FOR ACTIVE NEGATION
- LOGIC COMMAND DISCONNECTS ALL TERMINATION LINES
- CURRENT LIMIT AND THERMAL PROTEC-TION
- COMPATIBLE WITH SCSI 1, 2, 3, AND FAST-20 STANDARDS
- HOT SWAP COMPATIBLE
- CONSULT FACTORY FOR APPLICATION TEST REPORT: 5207TR

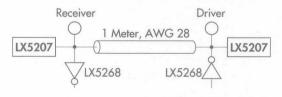
#### PRODUCT HIGHLIGHT

RECEIVING WAVEFORM - 20MHz



DRIVING WAVEFORM - 20MHz





PACKAGE ORDER INFORMATION

 T<sub>A</sub> (°C)
 N
 Plastic DIP 24-pin
 DWP Plastic SOWB 28-pin, Power

 0 to 70
 LX5207CN
 LX5207CDWP

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5207CDWPT) For An In-Depth
Discussion On Applying
SCSI, Request Linfinity
Application Note:
"Understanding The
Single-Ended SCSI Bus"

FOR FURTHER INFORMATION CALL (714) 898-8121

#### 18-Line Low Capacitance, µPower SCSI Terminator

#### TRANS ATA O MOST PRODUCTION DATA SHEET

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#### THERMAL DATA

#### NIDACKAGE

terminal

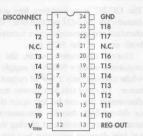
N PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{\mathrm{JA}}}$	52°C/W
DWP PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO LEADS, $\theta_{_{JL}}$	18°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{j_A}$	40°C/W

Junction Temperature Calculation:  $T_j = T_A + (P_D \times \theta_{jA})$ . The  $\theta_{jA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

#### Power Up / Power Down Function Table

Outputs	Quiescent Current
Enabled	800μΑ
HIZ	0.5µA
HIZ	0.5μΑ
	Enabled HI Z

#### PACKAGE PIN OUTS



#### N PACKAGE (Top View)



(Top View)



#### PRODUCTION DATA SHEET

RECOMMENDED OPERATING CONDITIONS (Note 2)								
Parameter	Symbol	Recommended Operating Conditions			Units			
Parameter	Syllidol	Min.	Тур.	Max.	Units			
Termpwr Voltage	V <sub>TERM</sub>	4		5.25	V			
Signal Line Voltage	Acres de la constante de la co	0		5	V			
Disconnect Input Voltage	F F F F F F F F F F F F F F F F F F F	0		V <sub>TERM</sub>	V			
Output Capacitance on REGOUT		4.7		- t. z. Drijej O O eru	μF			
Operating Virtual Junction Temperature Range								
LX5207C		0	344	125	°C			

Note 2. Range over which the device is functional.

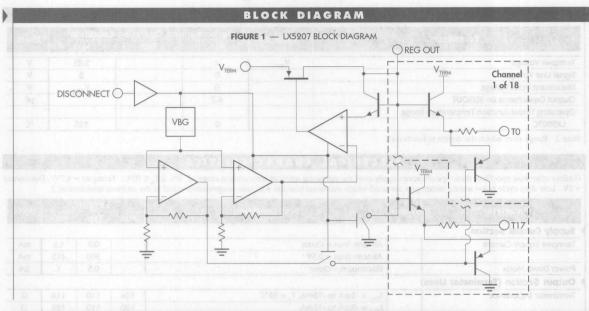
#### ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperature range of  $0^{\circ}\text{C} \leq \text{T}_{A} \leq 70^{\circ}\text{C}$ . Termpwr = 4.75V, Disconnect = 0V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions		LX5207		Unit
raiailletei	Sylliooi	Test Collations	Min.	Тур.	Max.	Oill
Supply Current Section						
Termpwr Supply Current		All term lines = Open		0.8	1.5	m/
16.0		All term lines = 0.5V		390	415	mA
Power Down Mode		Disconnect = Open		0.5	1	μА
Output Section (Terminator Li	nes)					
Terminator Impedance		I <sub>TERM</sub> = -5mA to -15mA, T <sub>A</sub> = 25°C	104	110	116	Ω
		I <sub>TERM</sub> = -5mA to -15mA	100	110	120	Ω
Terminator Output High Voltage			2.65	2.9		V
Max. Output Current		$V_{OUT} = 0.5V, T_A = 25^{\circ}C$	-20.3	-21.8	-23	m/
	. 109	$V_{OUT} = 0.5V, 0^{\circ}C \le T_{A} \le 70^{\circ}C$	-19.0	-21.8	-23	m/
		$V_{OUT} = 0.5V, V_{TERM} = 4V, T_A = 25^{\circ}C$	-19.5	-21.8	-23	m/
	hanneld.	$V_{OUT} = 0.5V$ , $V_{TERM} = 4V$ , $0^{\circ}C \le T_{A} \le 70^{\circ}C$	-18.0	-21.8	-23	m/
Output Leakage		Disconnect = Open, V <sub>TERM</sub> = 0V to 5.25V	192	10	400	nA
Output Capacitance		Disconnect = Open		2.5		pF
Sink Current	w lesson	V <sub>OUT</sub> = 4V	70	100	h	m/
Regulator Section		- 10 gr	-		Q.	
Regulator Output Voltage			meziri	3.6	1	V
Line Regulation	and the second	V <sub>TERM</sub> = 4V to 6V	+ 1	10	20	m\
Load Regulation		I <sub>REG</sub> = 0 to -100mA		20	50	m\
Drop Out Voltage	-1/10/201	$I_{REG} = -100 \text{mA}$	1 10000	0.45	1.0	٧
Short Circuit Current		V <sub>REG</sub> = 0V		-800	-1.100	m/
Thermal Shutdown				150		°C
Disconnect Section				tharea	rgat	
Disconnect Threshold	1233127		0.8	Pig 1 1	2.0	V
Input Current		Disconnect = 0V	AUST		40	μА

#### 18-Line Low Capacitance, µPower SCSI Terminator

#### PRODUCTION DATA SHEET



#### APPLICATION SCHEMATIC FIGURE 2 — 8/16-BIT SCSI SYSTEM APPLICATION Narrow **PERIPHERAL** Narrow TERM POWER TERM POWER DB (0) -DB (0) DISCONNECT DB (1) -DB (1) LX5207 LX5207 ₹ DB (14) DB (14)5 ₹ DB (15) DB (15)5 REGOUT REGOUT ₹ DB (P1) DB (P1) 5 TERMPWR **TERMPWR** Wide Wide $V_{\text{TERM}}$ VTERN MSG. MSG 5 DISCONNECT → RST -**SCSI CABLE** RST 5 LX5212 LX5212 ACK ACK 5 → BSY REGOUT BSY 5 REGOUT \_\_\_\_ 2.2μF 2.2µF → ₹ ATN ATN 5





18-Line Low Capacitance, µPower SCSI Terminator

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#### DESCRIPTION

The LX5208 is an eighteen-line active terminator for the SCSI parallel bus. This SCSI standard recommends active termination at both ends of the SCSI bus.

During disconnect mode, the LX5208 requires a meager 60µA of supply current while offering only 3.5pF of output capacitance. To enter this low-power mode, the disconnect pin can be left open (floating) or driven high, thereby disconnecting the terminating resistors and placing the internal low dropout regulator into low-power mode. In disconnect mode, each termination line presents a high impedance to the SCSI bus with the overall effect being to preserve high signal integrity and yield subsequent reliable, error free communications.

During normal operation, the LX5208 consumes only 800µA of current, which is the

lowest enabled supply current of any terminator available on the market today. Linfinity's proprietary BiCMOS low dropout regulator architecture enables this unique and very efficient operating characteristic.

The LX5208 also offers a precisely trimmed channel output current specified to a 5% tolerance. The maximum value of the output current is trimmed as closely as possible to the SCSI standard maximum specification to give the highest possible noise margin for fast SCSI operation. And the LX5208 sinks up to 200mA of current making it compatible with today's fast active negation drivers.

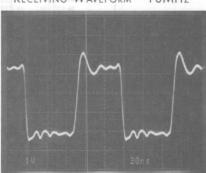
The LX5208 is a superior, pin-for-pin replacement for a variety of industry products such as the UC5601, UC5602, UC5608, and UC5609

#### KEY FEATURES

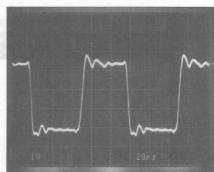
- 3.5pf OUTPUT CAPACITANCE DURING DISCONNECT
- 60µA SUPPLY CURRENT IN DISCON-NECT MODE
- 800µA SUPPLY CURRENT DURING NORMAL OPERATION
- 200mA SINK CURRENT FOR ACTIVE NEGATION
- LOGIC COMMAND DISCONNECTS ALL TERMINATION LINES
- CURRENT LIMIT AND THERMAL PROTECTION
- COMPATIBLE WITH SCSI 1, 2 AND 3 STANDARDS
- CONSULT FACTORY FOR APPLICATION TEST REPORT: **5208TR**

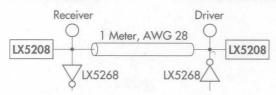
#### PRODUCT HIGHLIGHT

RECEIVING WAVEFORM - 10MHz



DRIVING WAVEFORM - 10MHz





Note: All surface-mount packages are available in Tape & Reel Append the letter "T" to part number. (i.e. LX5208CDWPT)

For An In-Depth
Discussion On Applying
SCSI, Request Linfinity
Application Note:
"Understanding The
Single-Ended SCSI Bus"

#### FOR FURTHER INFORMATION CALL (714) 898-8121

#### 18-Line Low Capacitance, µPower SCSI Terminator

#### TRANS ATA OF PRODUCTION DATA SHEET

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Storage Temperature Range ......-65°C to 150°C

#### THERMAL DATA

#### N PACKAGE

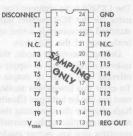
N PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	52°C/W
DWP PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO LEADS, $\theta_{_{JL}}$	18°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{J_{A}}}$	40°C/W

Junction Temperature Calculation:  $T_J = T_A + (P_D \times \theta_{JA})$ . The  $\theta_{JA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

#### POWER UP / POWER DOWN FUNCTION TABLE

Disconnect	Outputs	Quiescent Current
L	Enabled	800µA
Н	HIZ	60µA
Open	HIZ	60µA

#### PACKAGE PIN OUTS



#### N PACKAGE (Top View)



(Top View)



#### PRODUCTION DATA SHEET

Parameter	Symbol	Recommen	ded Operating	Conditions	Units
Farallieter	Sylliooi	Min.	Тур.	Max.	Units
TermPwr Voltage	V <sub>TERM</sub>	4		5.25	٧
Signal Line Voltage		0		5	٧
Disconnect Input Voltage		0		V <sub>TERM</sub>	٧
Output Capacitance on REGOUT	7	4.7		P THE PROPERTY OF	μF
Operating Virtual Junction Temperature Range					
LX5208C	VIII I	0	W.	125	°C

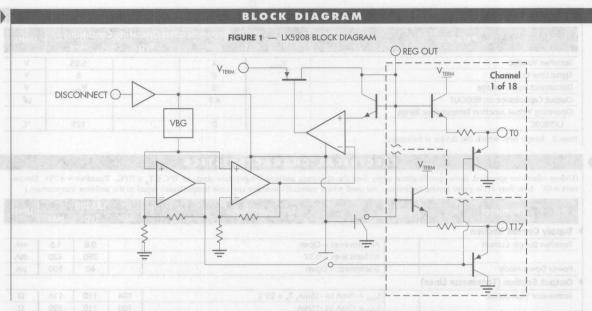
#### ELECTRICAL CHARACTERISTICS

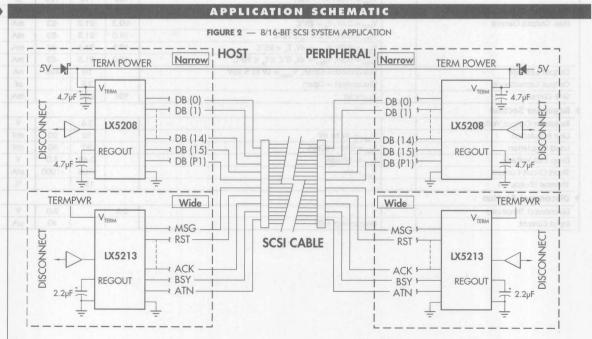
(Unless otherwise specified, these specifications apply over the operating ambient temperature range of  $0^{\circ}\text{C} \leq T_{A} \leq 70^{\circ}\text{C}$ . TermPwr = 4.75V, Disconnect = 0V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions		LX5208		Unit
Faranieter	Symbol	rest Conditions	Min.	Тур.	Max.	Oilit
Supply Current Section						
TermPwr Supply Current		All term lines = Open	THE RESERVE	0.8	1.5	mA
		All term lines = 0.5V		390	430	mA
Power Down Mode		Disconnect = Open		60	100	μА
Output Section (Terminator Lin	es)			R		
Terminator Impedance		I <sub>TERM</sub> = -5mA to -15mA, T <sub>A</sub> = 25°C	104	110	116	Ω
		I <sub>TERM</sub> = -5mA to -15mA	100	110	120	Ω
Terminator Output High Voltage		STOM THOSE NO TROUBLESSES	2.65	2.9		٧
Max. Output Current		$V_{OUT} = 0.5V, T_A = 25^{\circ}C$	-20.3	-21.8	-23	mA
	323	$V_{OUT} = 0.5V, 0^{\circ}C \le T_{A} \le 70^{\circ}C$	-19.0	-21.8	-23	mA
		V <sub>OUT</sub> = 0.5V, V <sub>TERM</sub> = 4V, T <sub>A</sub> = 25°C	-19.5	-21.8	-23	- mA
	wannik	$V_{OUT} = 0.5V, V_{TERM} = 4V, 0^{\circ}C \le T_A \le 70^{\circ}C$	-18.0	-21.8	-23	mA
Output Leakage		Disconnect = Open, V <sub>TERM</sub> = 0V to 5.25V		10	400	nA
Output Capacitance		Disconnect = Open		3.5		pF
Sink Current	7 (7) 9/1	V <sub>out</sub> = 4V	100	200	NA	mA
Regulator Section	11183		1		9	
Regulator Output Voltage			X 9208	3.6	4 6	V
Line Regulation	The Friday	V <sub>TERM</sub> = 4V to 6V		10	20	mV
Load Regulation	- is ri no	I <sub>REG</sub> = 0 to -100mA	Design Transport	20	50	mV
Drop Out Voltage	- Indian	I <sub>REG</sub> = -100mA	-	0.45	1.0	٧
Short Circuit Current		V <sub>REG</sub> = OV	THE PARTY	-700	-1000	mA
Thermal Shutdown	7		- Br	150		°C
Disconnect Section	T.dotal			SWA	MRST	-
Disconnect Threshold			0.8	77	2.0	V
Input Current	I delegan	Disconnect = 0V	A00	1	40	μА

### 18-Line Low Capacitance, µPower SCSI Terminator

#### PRODUCTION DATA SHEET











THE INFINITE POWER OF INNOVATION PRODUCTION DATA SHEET

#### DESCRIPTION

The LX5212 is a nine-line active terminator for the SCSI parallel bus. This SCSI standard recommends active termination at both ends of the SCSI bus.

During disconnect mode, the LX5212 requires a meager 500nA of supply current while offering only 2.5pF of output capacitance. To enter this low-power mode, the disconnect pin can be left open (floating) or driven high, thereby disconnecting the terminating resistors and placing the internal low dropout regulator into low-power mode. In disconnect mode, each termination line presents a high impedance to the SCSI bus with the overall effect being to preserve high signal integrity and yield subsequent reliable, error-free communica-

During normal operation, the LX5212

consumes only 600uA of current, which is the lowest enabled supply current of any terminator available on the market today. Linfinity's proprietary BiCMOS low dropout regulator architecture enables this unique and very efficient operating characteristic.

The LX5212 also offers a precisely trimmed channel output current specified to a 5% tolerance. The maximum value of the output current is trimmed as closely as possible to the SCSI standard maximum specification to give the highest possible noise margin for fast SCSI operation. And the LX5212 sinks up to 30mA of current, making it compatible with today's fast active negation drivers.

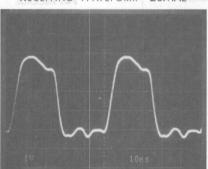
The LX5212 is a superior, pin-for-pin replacement for a variety of industry products, such as the UC5614.

#### KEY FEATURES

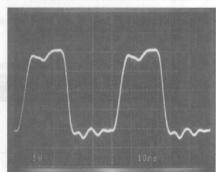
- 2.5pF OUTPUT CAPACITANCE DURING DISCONNECT
- 500nA SUPPLY CURRENT IN DISCONNECT
- 600µA SUPPLY CURRENT DURING NORMAL OPERATION
- 30mA SINK CURRENT FOR ACTIVE NEGATION
- LOGIC COMMAND DISCONNECTS ALL TERMINATION LINES
- CURRENT LIMIT AND THERMAL PROTECTION
- COMPATIBLE WITH SCSI 1, 2, 3, AND FAST 20 STANDARDS
- HOT SWAP COMPATIBLE
- CONSULT FACTORY FOR APPLICATION TEST REPORT: 5212TR
- **EVALUATION BOARD AVAILABLE**

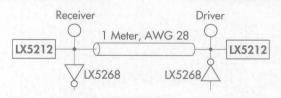
#### PRODUCT HIGHLIGHT

RECEIVING WAVEFORM - 20MHz



DRIVING WAVEFORM - 20MHZ





NOTE: -For An In-Depth Discussion On Applying SCSI, Request Linfinity Application Note: "Understanding The Single-Ended SCSI Bus"



Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5212CDPT)

#### FOR FURTHER INFORMATION CALL (714) 898-8121

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Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

# THERMAL DATA N PACKAGE: THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{\rm JA}$ THERMAL RESISTANCE-JUNCTION TO LEADS, $\theta_{\rm R}$ THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{\rm JA}$ THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{\rm JA}$ THERMAL RESISTANCE-JUNCTION TO LEADS, $\theta_{\rm R}$ THERMAL RESISTANCE-JUNCTION TO LEADS, $\theta_{\rm R}$ THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{\rm JA}$ THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{\rm JA}$ 50°C/W

Junction Temperature Calculation:  $T_J = T_A + (P_D \times \theta_{JA})$ . The  $\theta_{JA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

#### POWER UP / POWER DOWN FUNCTION TABLE

Disconnect	Outputs	Quiescent Current
L + 1/4	Enabled	600µA
Н	HIZ	0.5μΑ
Open	HIZ	0.5µA

#### PACKAGE PIN OUTS 15 T5 T8 🗆 T9 🗆 14 REG OUT N.C. 13 N.C. GND [ 12 N.C. 11 V<sub>TERM</sub> 10 T4 9 T3 DISCONNECT [ T1 [ N PACKAGE (Top View) T8 🗆 T9 🗆 N.C. 21 N.C. GND \_\_\_ 20 N.C. 19 N.C. N.C. \_\_\_\_\_ 6 18 \_\_\_\_ N.C. N.C. - 7 17 N.C. N.C. 18 N.C. 🗆 9 16 N.C. DISCONNECT . 11 11 14 T4 13 T3 T2 12 PWP PACKAGE (Top View) T8 🖂 2 15 T5 T9 🗆 14 REG OUT Heatsink { N.C. \_\_\_\_\_ 4 13 N.C. Heatsink 12 N.C. T2 🗆 8 DP PACKAGE (Top View)

#### PRODUCTION DATA SHEET

RECOMMENDED OPERATING CONDITIONS (Note 2)								
Parameter			Recommended Operating Conditions					
Faialleter	Symbol	Min.	Тур.	Max.	Units			
TermPwr Voltage	V <sub>TERM</sub>	4		5.25	V			
Signal Line Voltage	9	0		5	V			
Disconnect Input Voltage		0		V <sub>TERM</sub>	V			
Output Capacitor on REGOUT		2.2		DANNOCKIU	μF			
Operating Virtual Junction Temperature Range								
LX5212C		0	V .	125	°C			

Note 2. Range over which the device is functional.

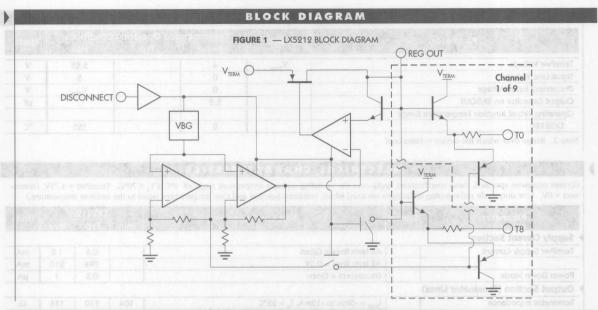
#### ELECTRICAL CHARACTERISTICS

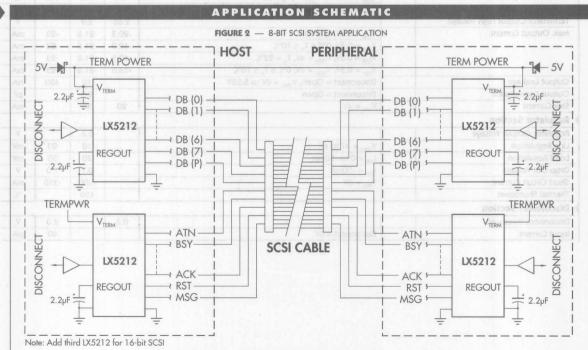
(Unless otherwise specified, these specifications apply over the operating ambient temperature range of  $0^{\circ}\text{C} \leq \text{T}_{A} \leq 70^{\circ}\text{C}$ . TermPwr = 4.75V, Disconnect = 0V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Cumbal	Test Conditions			LX5212		Units
Farameter	Symbol			Min.	Тур.	Max.	Units
Supply Current Section							
TermPwr Supply Current		All term lines = Open		100	0.6	1.2	mA
		All term lines = 0.5V		THE REAL PROPERTY.	194	210	mA
Power Down Mode		Disconnect = Open			0.5	1	μА
Output Section (Terminator Lin	es)		1 - 2 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -				
Terminator Impedance	7	I <sub>TERM</sub> = -5mA to -15mA, T <sub>A</sub> = 25°C		104	110	116	Ω
	78 12 13 1	I <sub>TERM</sub> = -5mA to -15mA		100	110	120	Ω
Terminator Output High Voltage				2.65	2.9	1965 - 57 - W	٧
Max. Output Current	100	V <sub>OUT</sub> = 0.5V, T <sub>A</sub> = 25°C		-20.3	-21.8	-23	mA
		$V_{OUT} = 0.5V, 0^{\circ}C \le T_A \le 70^{\circ}C$		-19.0	-21.8	-23	mA
		$V_{OUT} = 0.5V, V_{TERM} = 4V, T_A = 25^{\circ}C$		-19.5	-21.8	-23	mA
		$V_{OUT} = 0.5V, V_{TERM} = 4V, 0^{\circ}C \le T_{A} \le 70^{\circ}C$		-18.0	-21.8	-23	mA
Output Leakage		Disconnect = Open, V <sub>TERM</sub> = 0V to 5.25V			10	400	nA
Output Capacitance	× 14 1	Disconnect = Open	Contract comme	3/95	2.5	2.00	pF
Sink Current	4 1 1 0d -1	V <sub>OUT</sub> = 4V	-11.00	20	30	0	mA
Regulator Section	(1) sec			nkeav		A 2	
Regulator Output Voltage			- 153 meg -	1	3.6	1 8	٧
Line Regulation	Ball 410	V <sub>IERM</sub> = 4V to 6V	101 00		10	20	mV
Load Regulation	Up du	I <sub>REG</sub> = 0 to -50mA	an art	1000	20	50	mV
Drop Out Voltage	117 00	I <sub>REG</sub> = -50mA	10.00		0.7	1.0	٧
Short Circuit Current		V <sub>REG</sub> = 0V			-200	-350	mA
Thermal Shutdown					150		°C
Disconnect Section					N/O	WHI	
Disconnect Threshold				0.8	N	2.0	V
Input Current	A MARK	Disconnect = 0V				40	μА

# 9-Line Low Capacitance, µPower SCSI Terminator

#### PRODUCTION DATA SHEET











THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

The LX5213 is a nine-line active terminator for the SCSI parallel bus. This SCSI standard recommends active termination at both ends of the SCSI bus.

During disconnect mode, the LX5213 requires a meager 60µA of supply current while offering only 3.5pF of output capacitance. To enter this low-power mode, the disconnect pin can be left open (floating) or driven high, thereby disconnecting the terminating resistors and placing the internal low dropout regulator into low-power mode. In disconnect mode, each termination line presents a high impedance to the SCSI bus with the overall effect being to preserve high-signal integrity and yield subsequent reliable, error-free communications.

During normal operation, the LX5213 con-

sumes only 600µA of current, which is the lowest enabled supply current of any terminator available on the market today. Linfinity's proprietary BiCMOS low dropout regulator architecture enables this unique and very efficient operating characteristic.

The LX5213 also offers a precisely trimmed channel output current specified to a 5% tolerance. The maximum value of the output current is trimmed as closely as possible to the SCSI standard maximum specification to give the highest possible noise margin for fast SCSI operation. And the LX5213 sinks up to 150mA of current, making it compatible with today's fast active negation drivers.

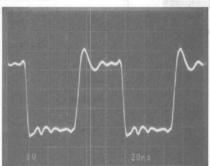
The LX5213 is a superior, pin-for-pin replacement for a variety of industry products such as the UC5603 and UC5613.

#### KEY FEATURES

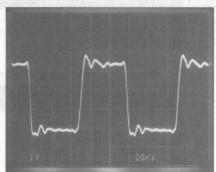
- 3.5pf OUTPUT CAPACITANCE DURING DISCONNECT
- 60µA SUPPLY CURRENT IN DISCON-NECT MODE
- 600µA SUPPLY CURRENT DURING NORMAL OPERATION
- 150mA SINK CURRENT FOR ACTIVE NEGATION
- LOGIC COMMAND DISCONNECTS ALL TERMINATION LINES
- CURRENT LIMIT AND THERMAL PROTECTION
- COMPATIBLE WITH SCSI 1, 2 AND 3 STANDARDS
- CONSULT FACTORY FOR APPLICATION TEST REPORT: 5213TR

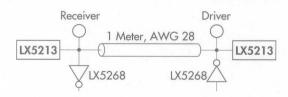
#### PRODUCT HIGHLIGHT

RECEIVING WAVEFORM - 10MHz



DRIVING WAVEFORM - 10MHz





For An In-Depth
Discussion On Applying
SCSI, Request Linfinity
Application Note:
"Understanding The
Single-Ended SCSI Bus"

# PACKAGE ORDER INFORMATION T<sub>A</sub> (°C) N Plastic DIP 16-pin PWP Plastic TSSOP 24-pin, Power DP Plastic SOIC 16-pin, Power 0 to 70 LX5213CN LX5213CPWP LX5213CDP

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5213CDPT)

#### FOR FURTHER INFORMATION CALL (714) 898-8121

#### ABSOLUTE MAXIMUM RATINGS (Note 1)

TermPwr Voltage	+7V
Signal Line Voltage	
Regulator Output Current	0.4A
Operating Junction Temperature	
Plastic (N, PWP, DP Packages)	150°C
Storage Temperature Range	65°C to 150°C
Lead Temperature (Soldering, 10 seconds)	300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

#### THERMAL DATA

#### N PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{ m JA}}$	65°C/W
PWP PACKAGE:	recursion for a early
THERMAL RESISTANCE-JUNCTION TO LEADS, $\theta_{_{\rm IL}}$	27°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	60°C/W
DP PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO LEADS, $\theta_{_{\rm JL}}$	20°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{\mathrm{JA}}}$	45°C/W

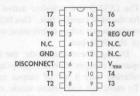
Junction Temperature Calculation:  $T_1 = T_1 + (P_2 \times \theta_1)$ .

The  $\theta_{IA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

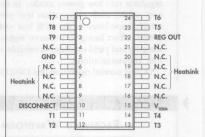
#### Power Up / Power Down Function Table

Disconnect	sconnect Outputs	
L	Enabled	600µА
Н	HIZ	60µA
Open	HIZ	60µA

#### PACKAGE PIN OUTS



N PACKAGE (Top View)



PWP PACKAGE

(Top View)



DP PACKAGE (Top View)



#### PRODUCTION DATA SHEET

		Recommend	Units		
Parameter	Symbol	Min.	Тур.	Typ. Max.	
TermPwr Voltage	V <sub>TERM</sub>	4		5.25	٧
Signal Line Voltage		0		5	٧
Disconnect Input Voltage		0		V <sub>TERM</sub>	٧
Output Capacitor on REGOUT		2.2	-<	DEVENOUS	μF
Operating Virtual Junction Temperature Range		present.	-		
LX5213C		0	SA P	125	°C

Note 2. Range over which the device is functional.

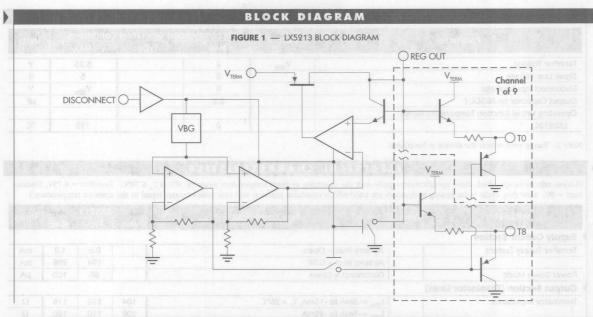
#### ELECTRICAL CHARACTERISTICS

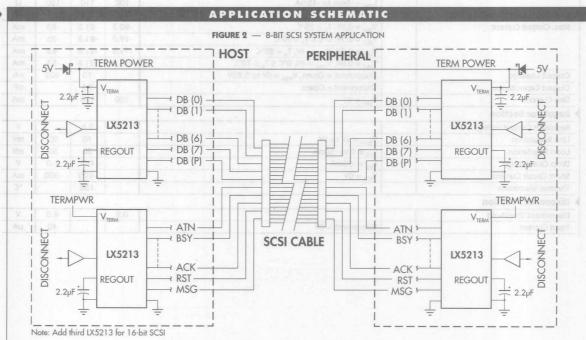
(Unless otherwise specified, these specifications apply over the operating ambient temperature range of  $0^{\circ}$ C  $\leq T_{A} \leq 70^{\circ}$ C. TermPwr = 4.75V, Disconnect = 0V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter Symbol Test Conditions			LX5213	LX5213		
Parameter	Symbol	or rest conditions		Тур.	Max.	Unit
Supply Current Section						
TermPwr Supply Current		All term lines = Open		0.6	1.2	mA
		All term lines = 0.5V	100	194	208	mA
Power Down Mode		Disconnect = Open		60	100	μА
<b>Output Section (Terminator Lin</b>	es)					
Terminator Impedance	$I_{TERM} = -5 \text{mA to } -15 \text{mA}, T_A = 25 ^{\circ}\text{C}$		104	110	116	Ω
		I <sub>TERM</sub> = -5mA to -15mA	100	110	120	Ω
Terminator Output High Voltage		PTA SOCIETA DE LA DELIGIO DE LA CONTRA DEL CONTRA DE LA CONTRA DELIGIA DE LA CONTRA DEL CONTRA DE LA CONTRA DEL CONTRA DE LA CONTRA DE LA CONTRA DE LA CONTRA DE LA CONTRA DE	2.65	2.9		٧
Max. Output Current		V <sub>OUT</sub> = 0.5V, T <sub>A</sub> = 25°C	-20.3	-21.8	-23	mA
		$V_{OUT} = 0.5V, 0^{\circ}C \le T_{A} \le 70^{\circ}C$	-19.0	-21.8	-23	mA
		$V_{OUT} = 0.5V, V_{TERM} = 4V, T_A = 25^{\circ}C$	-19.5	-21.8	-23	mA
		$V_{OUT} = 0.5V, V_{TERM} = 4V, 0^{\circ}C \le T_{A} \le 70^{\circ}C$	-18.0	-21.8	-23	mA
Output Leakage		Disconnect = Open, V <sub>TERM</sub> = 0V to 5.25V		10	400	nA
Output Capacitance		Disconnect = Open	- MO.	3.5		pF
Sink Current	(3).80	V <sub>OUT</sub> = 4V	100	150	2.5	mA
Regulator Section		1-1000		1 71	ij.	
Regulator Output Voltage			FEREN	3.6	LI	٧
Line Regulation	(5) 80	V <sub>TERM</sub> = 4V to 6V		10	20	mV
Load Regulation	[N] 80	$I_{REG} = 0 \text{ to } -50\text{mA}$	TUOCE	20	50	mV
Drop Out Voltage	(4) 80	$I_{REG} = -50 \text{mA}$		0.7	1.0	V
Short Circuit Current		$V_{REG} = 0V$		-200	-350	mA
Thermal Shutdown				150		°C
Disconnect Section				SVASI	WHIT	7.39
Disconnect Threshold			0.8	7	2.0	٧
Input Current	- PRA	Disconnect = 0V			40	μА

# 9-Line Low Capacitance, µPower SCSI Terminator

#### PRODUCTION DATA SHEET









#### ULTRA 9-CHANNEL SCSI TERMINATOR

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

The LX5218 and LX5219 represent next-generation technology for SCSI termination applications. The low voltage BiCMOS architecture employed in their design offers superior performance to older passive and active techniques. The architecture employs high-speed adaptive elements for each channel, providing the fastest response possible. The channel bandwidth is typically 35MHz. The LX5218/19 compare favorably to older linear regulator approaches whose bandwidth's are dominated by the output compensation capacitor and are limited to the 500KHz bandwidth region (see further discussion in the Functional Description section). The new architechture also eliminates the output compensation capacitor typical in earlier terminator designs. Each is approved for use with SCSI 1, 2, 3, ULTRA and beyond - providing the highest performance alternative available today.

Another key improvement lies in their ability to insure reliable, error free communications even in systems which do not necessarily adhere to recommended SCSI hardware design guidelines, such as the use of improper cable lengths and impedances. Frequently, this situation is not controlled by the peripheral or host designer and, when problems occur, they are the first to be made aware of the problem. The LX5218/19 architecture

is much more tolerant of marginal system integrations.

Recognizing the needs of portable and configurable peripherals, the LX5218/19 has a TTL compatible sleep/disable mode. Quiescent current is typically less than (275µA) in this mode, while the output capacitance is also less than 4pF. The obvious advantage of extended battery life for portable systems is inherent in the product's sleep mode feature. Additionally, the disable function permits factory floor or production-line configurability, reducing inventory and productline diversity costs. Field configurability can also be accomplished without physically removing components which, oftentimes results in field returns due to mishandling.

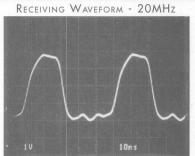
Reduced component counts is also inherent in the LX5218/19 architecture. Traditional termination techniques require large stabilization and transient protection capacitors of up to 20µF in value and size. The LX5218/19 architecture does not require these components, allowing all the cost savings associated with inventory, board space, assembly, reliability, and component costs.

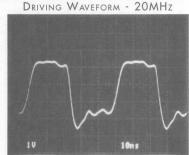
The difference between the LX5218 and the LX5219 is the sleep mode logic. The LX5218 is Active Low Logic. The LX5219 is Active High Logic.

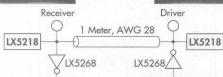
#### KEY FEATURES

- ULTRA-FAST RESPONSE FOR FAST-20 SCSI APPLICATIONS
- 35MHz CHANNEL BANDWIDTH
- 3.5V OPERATION
- LESS THAN 4pF OUTPUT CAPACITANCE
- SLEEP MODE CURRENT LESS THAN 275µA
- THERMALLY SELF LIMITING
- <u>NO</u> EXTERNAL COMPENSATION CAPACITORS
- IMPLEMENTS 8-BIT OR 16-BIT (WIDE)
  APPLICATIONS
- COMPATIBLE WITH ACTIVE NEGATION DRIVERS (60mA / CHANNEL)
- COMPATIBLE WITH PASSIVE AND ACTIVE TERMINATIONS
- APPROVED FOR USE WITH SCSI 1, 2, 3 AND ULTRA
- CONSULT FACTORY FOR APPLICATION TEST REPORT: **5218TR**
- **EVALUATION BOARD AVAILABLE**

#### PRODUCT HIGHLIGHT







# For An In-Depth Discussion On Applying SCSI, Request Linfinity Application Note: "Understanding The Single-Ended SCSI Bus"

NOTE: -

#### PACKAGE ORDER INFORMATION

T, (°C)	DW Plastic SOWB 16-pin	PW Plastic TSSOP 20-pin
0 to 125	LX5218CDW	LX5218CPW
0 to 125	LX5219CDW	LX5219CPW

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5218CDWT)

FOR FURTHER INFORMATION CALL (714) 898-8121

#### 

Continuous Output Voltage Range 0 to 5.5V Continuous Disable Voltage Range 0 to 5.5V Operating Junction Temperature 0 Cor to 125°C Storage Temperature Range -65°C to +150°C Solder Temperature (Soldering, 10 seconds) 300°C

Note 1. Exceeding these ratings could cause damage to the device.

#### THERMAL DATA

#### DW PACKAGE:

DITTACIONOL.	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	95°C/W
PW PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{IA}$	144°C/W

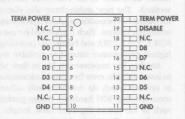
Junction Temperature Calculation:  $T_1 = T_A + (P_D \times \theta_{IA})$ .

The  $\theta_A$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

#### PACKAGE PIN OUTS

TERM POWER I	1 tonk 80	16	TERM POWER
N.C.	2	15	
D0 🖂	3	14	DISABLE
D1 🖂	4	13	□ D8
D2 🞞	5	12	□ D7
D3 🞞	6	11	□ D6
D4 🖂	7	10	□ D5
GND	8	9	

DW PACKAGE (Top View)



PW PACKAGE (Top View)

#### ULTRA 9-CHANNEL SCSI TERMINATOR

#### PRODUCTION DATA SHEET

RECOMMENDED (	OPERATING C	ONDITION	<b>S</b> (Note 2)		
	Symbol	Recommended Operating Conditions			Units
Parameter	Symoon	Min.	Тур.	Max.	Units
Termination Voltage	V <sub>TERM</sub>	3.5		5.5	V
High Level Disable Input Voltage	V <sub>IH</sub>	2		V <sub>TERM</sub>	V
Low Level Disable Input Voltage	V <sub>IL</sub>	0	JAANSEH 3	0.8	V
Operating Virtual Junction Temperature Range	200000	100	murson d		
LX5218C		0		125	°C
LX5219C		0		125	°C

# ELECTRICAL CHARACTERISTICS

Note 2. Range over which the device is functional.

Term Power = 4.75V unless otherwise specified. Unless otherwise specified, these specifications apply at the recommended operating ambient temperature of  $T_A = 25$ °C. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.

Parameter		Symbol Test Conditions		LX5218 / LX5219			Units
		Symbol	rest collations	Min.	Тур.	Max.	Ollits
Output High Voltage	101	V <sub>out</sub>		2.65	2.85		V
TermPwr Supply Current		I <sub>cc</sub>	All data lines = open		6	9	mA
			All data lines = 0.5V	100	215	225	mA
	LX5218	The of	Disable Pin > 2V		275	1 31	μA
	LX5219		Disable Pin < 0.8V		375		μA
Output Current		lout	V <sub>OUT</sub> = 0.5V	-21	-23	-24	mA
Disable Input Current LX5218		I <sub>IN</sub>	Disable Pin = 4.75V		90		μA
			Disable Pin = 0V		-10	10-25-32	nA
	LX5219	MPR.	Disable Pin = 4.75V		10	I will be seen	nA
		decide in the	Disable Pin = 0V	month month	-90	series al	μΑ
Output Leakage Current	LX5218	l <sub>oL</sub>	Disable Pin = $> 2.0$ V, $V_O = 0.5$ V	to elementamit	10	where	nA
	LX5219	in skierii	Disable Pin = $< 0.8$ V, $V_O = 0.5$ V	sline il rele	10	W BOMBI	nA
Capacitance in Disabled Mode Cour		C <sub>OUT</sub>	V <sub>OUT</sub> = 0V, frequency = 1MHz	when the line	501418	remes to	pF
Channel Bandwidth		BW		vhich comus	35	vê terini.	MHz
Termination Sink Current, p	oer Channel	I <sub>SINK</sub>	V <sub>OUT</sub> = 4V	at , 60,000 T yills	60	n resistor	mA

State. Sidep me power conserved to the power will appear to the power to the power will appear to the power to the po

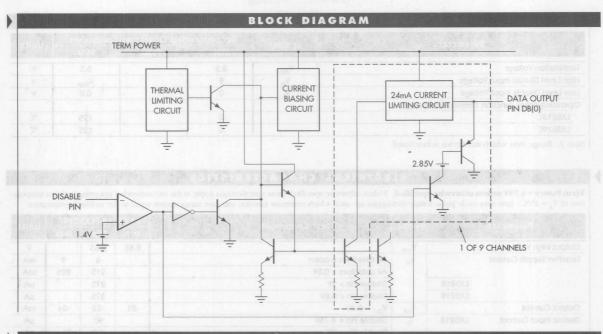
s reached.

Acting as a near ideal line terminator, the DS5218-19 closely eproduces the optimum case when the device is enabled. For entitle the device the Disable Pin must be pulled logic. Iow or left Open Cibe LSS219 Disable Pin must be pulled toget righ or left open to enable the devices. Oneing this node of coormion, autesseed current is final, and the device mode of coormion, autesseed current is final, and the device.



#### ULTRA 9-CHANNEL SCSI TERMINATOR

#### PRODUCTION DATA SHEET



#### FUNCTIONAL DESCRIPTION

Power Up / Power Down Function Table

Outputs

Enabled

HIZ

Enabled

Disable

LX5219

Н

Open

LX5218

Н

Open

Cable transmission theory suggests to optimize signal speed and quality, the termination should act both as an ideal voltage reference when the line is released (deasserted) and as an ideal current source when the line is active (asserted). Common active terminators, which consist of Linear Regulators in series

with resistors (typically  $110\Omega$ ), are a compromise. As the line voltage increases, the amount of current decreases linearly by the equation V = I \* R. The LX5218/19, with its unique new architecture applies the maximum amount of current regardless of line voltage until the termination high threshold (2.85V) is reached.

Acting as a near ideal line terminator, the LX5218/19 closely reproduces the optimum case when the device is enabled. To enable the device the Disable Pin must be pulled logic **Low** or left **Open** (The LX5219 Disable Pin must be pulled Logic High or left open to enable the device). During this mode of operation, quiescent current is 6mA and the device

will respond to line demands by delivering 24mA on assertion and by imposing 2.85V on deassertion. In order to disable the device, the Disable pin must be driven logic **High** (Logic <u>Low</u> for LX5219). This mode of operation places the device in a sleep state where a meager 275µA of quiescent current

Quiescent

Current

6mA

275µA

6mA

is consumed. Additionally, all out-

puts are in a Hi-Z (impedance) state. Sleep mode can be used for power conservation or to completely eliminate the terminator from the SCSI chain. In the second case, termination node capacitance is important to consider. The terminator will appear as a parasitic distributed capacitance on the line,

which can detract from bus performance. For this reason, the LX5218/19 has been optimized to have only 4pF of capacitance per output in the sleep state.

An additional feature of the LX5218/19 is its compatibility with active negation drivers. The device handles up to 60mA of sink current for drivers which exceed the 2.85V output high.



# ULTRA 9-CHANNEL SCSI TERMINATOR

PRODUCTION DATA SHEET

#### GRAPH / CURVE INDEX

#### Waveforms

#### FIGURE#

- 1A. RECEIVING WAVEFORM (Freq. = 1.0MHz)
- 1B. DRIVING WAVEFORM
- 2A. RECEIVING WAVEFORM (Freq. = 5.0MHz)
- 2B. DRIVING WAVEFORM
- 3. 10MHz WAVEFORM
- 4. 20MHz WAVEFORM

#### **Characteristic Curves**

#### FIGURE #

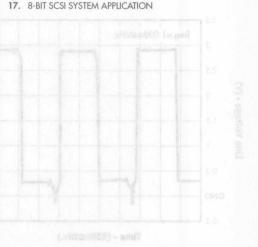
- 5. OUTPUT HIGH VOLTAGE vs. JUNCTION TEMPERATURE
- 6. OUTPUT CURRENT vs. JUNCTION TEMPERATURE
- 7. OUTPUT CURRENT vs. OUTPUT HIGH VOLTAGE ( $V_x = 4.75V$ )
- 8. OUTPUT CURRENT vs. OUTPUT HIGH VOLTAGE ( $V_T = 3.3V$ )
- 9. TERMINATION VOLTAGE vs. SUPPLY CURRENT
- 10. TERMPWR SUPPLY CURRENT vs. TERMINATION VOLTAGE (Disabled)
- 11. TERMPWR SUPPLY CURRENT vs. TERMINATION VOLTAGE (Disabled) -LX5219
- 12. OUTPUT HIGH VOLTAGE vs. JUNCTION TEMPERATURE ( $V_{\tau} = 3.3V$ )
- 13. OUTPUT CURRENT vs. JUCTION TEMPERATURE ( $V_x = 3.3V$ )
- 14. OUTPUT HIGH VOLTAGE vs. TERMINATION VOLTAGE
- 15. OUTPUT CURRENT vs. TERMINATION VOLTAGE
- 16. OUTPUT CURRENT MATCHING CHANNEL TO CHANNEL

#### FIGURE INDEX

#### **Application Circuits**

#### FIGURE #

17. 8-BIT SCSI SYSTEM APPLICATION





#### PRODUCTION DATA SHEET

#### CHARACTERISTIC CURVES

FIGURE 1A. — RECEIVING WAVEFORM

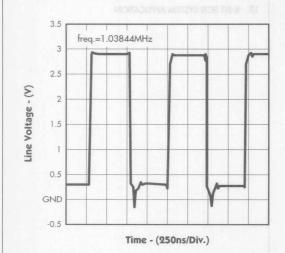
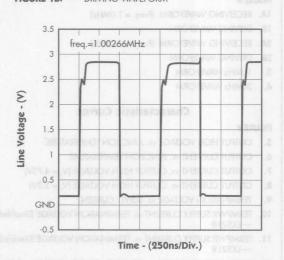
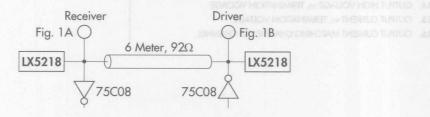


FIGURE 1B. — DRIVING WAVEFORM



#### END-DRIVEN CABLE

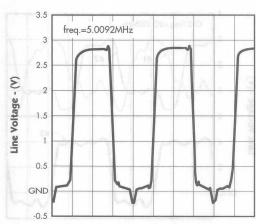


#### ULTRA 9-CHANNEL SCSI TERMINATOR

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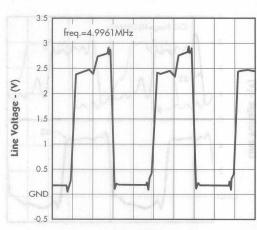
#### CHARACTERISTIC CURVES

FIGURE 2A. — RECEIVING WAVEFORM



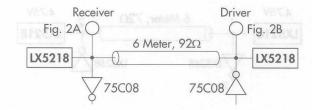
Time - (50ns/Div.)

FIGURE 2B. — DRIVING WAVEFORM



Time - (50ns/Div.)

#### END-DRIVEN CABLE



# ULTRA 9-CHANNEL SCSI TERMINATOR

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#### CHARACTERISTIC CURVES

FIGURE 3. — 10MHz WAVEFORM

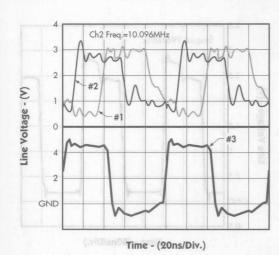
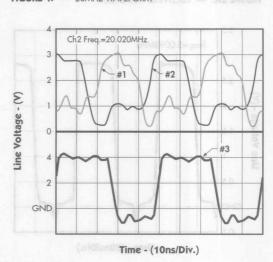
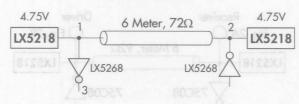


FIGURE 4. — 20MHz WAVEFORM



END-DRIVEN CABLE



#### ULTRA 9-CHANNEL SCSI TERMINATOR

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#### CHARACTERISTIC CURVES

FIGURE 5. — OUTPUT HIGH VOLTAGE vs. JUNCTION TEMP.

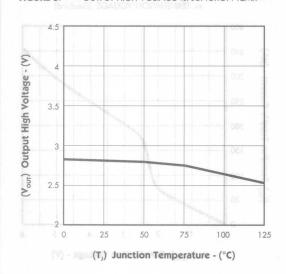


FIGURE 6. — OUTPUT CURRENT vs. JUNCTION TEMP.

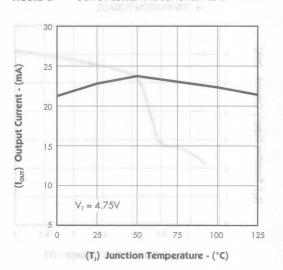


FIGURE 7. — OUTPUT CURRENT vs. OUTPUT HIGH VOLTAGE

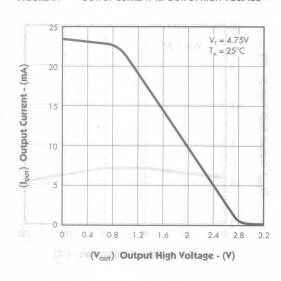
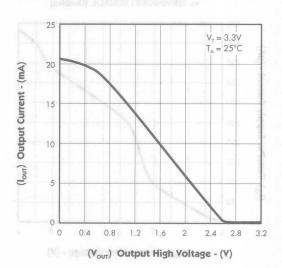


FIGURE 8. — OUTPUT CURRENT vs. OUTPUT HIGH VOLTAGE



# LX5218/LX5219

# ULTRA 9-CHANNEL SCSI TERMINATOR

PRODUCTION DATA SHEET

### CHARACTERISTIC CURVES

FIGURE 9. — TERMPWR SUPPLY CURRENT

vs. TERMINATION VOLTAGE

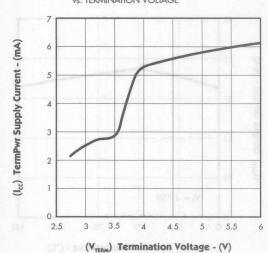


FIGURE 10. — LX5218 TERMPWR SUPPLY CURRENT vs. TERMINATION VOLTAGE (Disabled)

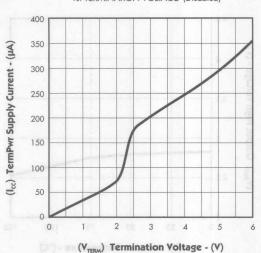


FIGURE 11. — LX5219 TERMPWR SUPPLY CURRENT vs. TERMINATION VOLTAGE (Disabled)

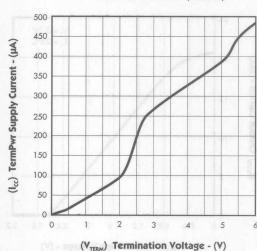
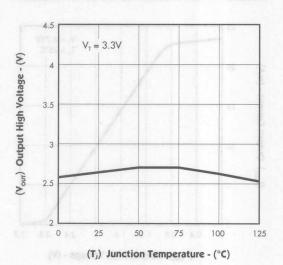


FIGURE 12. — OUTPUT HIGH VOLTAGE vs. JUNCTION TEMP.



# LX5218/LX5219

# ULTRA 9-CHANNEL SCSI TERMINATOR

PRODUCTION DATA SHEET

# CHARACTERISTIC CURVES

FIGURE 13. — OUTPUT CURRENT vs. JUNCTION TEMP.

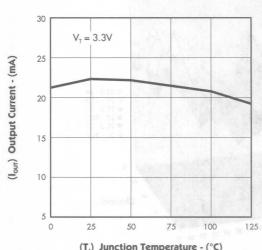
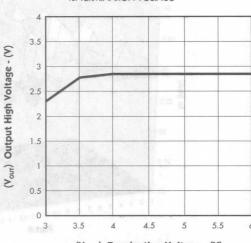


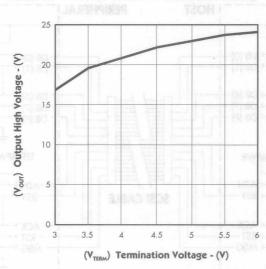
FIGURE 14. — OUTPUT HIGH VOLTAGE vs. TERMINATION VOLTAGE



(T,) Junction Temperature - (°C)

(V<sub>TERM</sub>) Termination Voltage - (V)

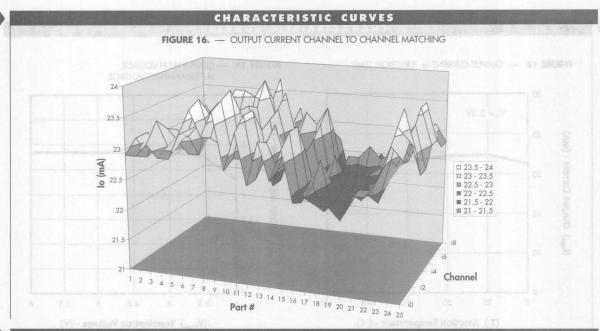
### FIGURE 15. — OUTPUT CURRENT vs. TERMINATION VOLTAGE



# LX5218/LX5219

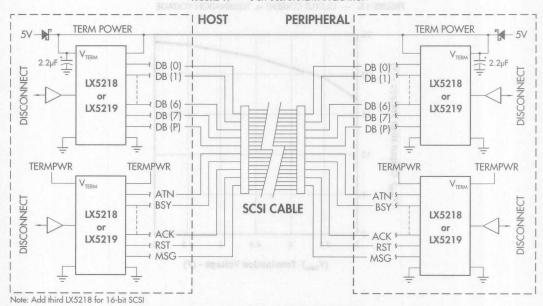
# ULTRA 9-CHANNEL SCSI TERMINATOR

PRODUCTION DATA SHEET



### APPLICATION SCHEMATIC

FIGURE 17 — 8-BIT SCSI SYSTEM APPLICATION







40MHz Single-Ended Inverting 6-Channel Bus Transceiver

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PRELIMINARY DATA SHEET

### DESCRIPTION

The LX5268 is a six-channel inverting transceiver that is used to drive and receive the signals from the single-ended Small Computer Systems Interface (SCSI) bus. The inverting drivers are programmable to function either as totem-pole or as open-drain outputs. The open-drain mode is used to drive the wired-OR lines of SCSI (BSY, SEL, RST). The totem-pole outputs provide active signal negation for higher signal-to-noise ratios on the bus. All the drivers and receivers may be disabled with the CE control pin. The A inputs of the drivers are taken high to ensure a low on the output when the input is open or to eliminate external pullup resistors. The drivers also feature controlled turn-on and turn-off times to reduce crosstalk in and RF emissions from the SCSI cable.

The LX5268 inverting receivers exhibit 600mV of hystersis and incorporate a 5ns pulse filter to reject high-frequency noise coupling from adjacent signal lines. These improvements to typically single-ended SCSI I/O's provide less data errors and higher data

throughput with less noise emissions. The DE/RE enable has a pulldown resistor on the input to ensure that the receiver is enabled when the DE/RE input is open.

The switching speeds of the LX5268 are sufficent to transfer data over the data bus at 80-million transfers per second. Proper bus termination is required to meet these data rates. Linfinity offers a broad range of terminator solutions such as the LX5218, 9-Channel Current Mode Terminator and the LX5208. 18-Channel Boulay Terminator. The pin assignment of the LX5268 and its enabling logic make this device applicable for the data path (8 data bits plus parity) for the SCSI bus.

This device is available in the spaceefficient shrink-small-outline package (SSOP) with 25-mil pin pitch. Each of the 6 identical channels conform to the requirements of ANSI X3.131 - 1986 (SCSI-1) and the proposed SCSI-2 and -3 standards.

The LX5268 is characterized for operation from 0°C to 70°C.

#### KEY FEATURES

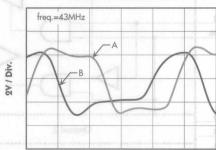
- OUTPUT CAPACITANCE: 15pf Typ.
- ACTIVE NEGATION (TOTEM-POLE) OR **OPEN-DRAIN; SELECTABLE DRIVER OUTPUTS**
- TOTEM-POLE; 40mA SOURCE / 48mA SINK CURRENT
- OPEN-DRAIN; 48mA SINK CURRENT
- CONTROLLED DRIVER RISE AND FALL TIMES 6ns TYPICAL
- LOW SKEW, t<sub>sk(lim)</sub> ... 4ns TYPICAL
- ☐ HIGH RECEIVER INPUT VOLTAGE HYSTERESIS - 600mV typ.
- RECEIVER INPUT NOISE PULSE FILTER 5ns MAXIMUM
- EACH DRIVER AND RECEIVER MEETS ANSI X3.131-1986 (SCSI-1) AND SCSI-2 & 3 STANDARDS
- POWER UP/DOWN GLITCH PROTECTION
- ☐ HIGH IMPEDANCE WITH V, AT 0V
- COMPATIBLE WITH ACTIVE TERMINATORS FROM LINFINITY:
  - LX5218, 9-Channel ULTRA
  - LX5212, 9-Channel Low Capacitance
  - LX5207, 18-Channel Low Capacitance

#### PRODUCT HIGHLIGHT

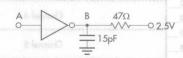
# RECEIVING WAVEFORM freq.=45MHz Α 2V / Div

Time - (5ns/Div.) 0 2.5V 15pF

# DRIVING WAVEFORM



Time - (5ns/Div.)



# PACKAGE ORDER INFO

Plastic SSOP DB TA (°C) 36-pin 0 to 70 LX5268CDB

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5268CDBT)

NOTE: -

For An In-Depth Discussion On Applying SCSI, Request Linfinity Application Note:

"Understanding The Single-Ended SCSI Bus"

FOR FURTHER INFORMATION CALL (714) 898-8121

# 40MHz Single-Ended Inverting 6-Channel Bus Transceiver

# THE 2 AT A SHEET S

# 

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

#### THERMAL DATA

#### DB PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT,  $\theta_{ij}$ 

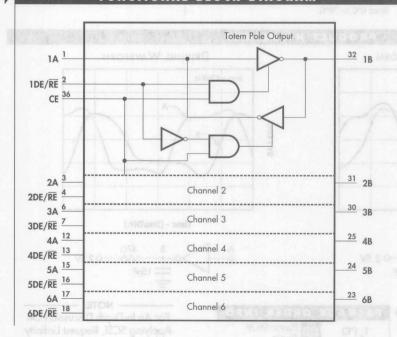
80°C/W

Junction Temperature Calculation:  $T_j = T_A + (P_D \times \theta_{jA})$ . The  $\theta_{jA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

#### 1A \_\_\_\_1 1 DE/RE \_\_\_\_ 2 35 N.C. 34 N.C. 2A 🗔 3 2 DE/RE \_\_\_\_ 4 N.C. \_\_\_\_ 5 3A 🗔 3 DE/RE \_\_\_\_ 7 30 3B U V GND 7 28 GND 27 GND GND III 10 GND III 11 26 \_\_\_\_ GND 25 \_\_\_\_ 4B 4A 🔲 12 4 DE/RE \_\_\_\_ 13 24 \_\_\_ 5B N.C. 5A \_\_\_\_ 15 22 N.C. 5 DE/RE \_\_\_\_ 16 N.C. 6A 1 17 20 N.C. 6 DE/RE \_\_\_\_ 18 (Top View)

PACKAGE PIN OUTS

# FUNCTIONAL BLOCK DIAGRAM



# 40MHz Single-Ended Inverting 6-Channel Bus Transceiver

# PRELIMINARY DATA SHEET

Par	ameter	Symbol	Recommen	ded Operating	Conditions	Units
Parameter		Symoon	Min.	Тур.	Max.	Onit
Supply Voltage		V <sub>cc</sub>	4.75	5	5.25	V
High-Level Input Voltage		V <sub>IH</sub>	2.0	systi worl or usit	smill yabsu noo	V
Low-Level Input Voltage		V <sub>IL</sub>	TEN JEBRO	PAST UDH OL MO	0.8	V
High-Level Output Current	Driver		RSP .	and the last rave	-40	mA
	Receiver	ОН		aval wall of the	-8	mA
Low-Level Output Current	Driver		19V	as usar mear can	48	mA
	Receiver	lot	48 1 18	an went would he	8	mA
Operating Virtual Junction Te	emperature Range:	g alo i asa ita a 'it	(surve)		York Tard W	NG 281U9
LX5268		T	0		125	°C

### Note 2. Range over which the device is functional.

### **ELECTRICAL CHARACTERISTICS**

(Unless otherwise specified, these specifications apply over the operating ambient temperatures of  $0^{\circ}C \le T_{A} \le 70^{\circ}C$ . Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions		LX5268		Unit
Farantetei	Symoon	rest conditions	Min.	Тур.	Max.	Oilit
Driver Section (Totem-Pole)						
High-Level Output Voltage	V <sub>OH</sub>	I <sub>OH</sub> = -20mA See Figure 1	2.0	S. E.M.	12.0	٧
Low-Level Output Voltage	V <sub>OL</sub>	I <sub>OL</sub> = 48mA See Figure 1			0.5	٧
High-Impedance State Output Current	loz	V <sub>o</sub> = GND			-1	μА
		$V_{o} = V_{cc}$			1	μΑ
Output Capacitance	C <sub>OUT</sub>			15		pF
Receiver Section	V					
High-Level Output Voltage	V <sub>OH</sub>	I <sub>OH</sub> = -8mA See Figure 2	2	3.5		V
Low-Level Output Voltage	VoL	I <sub>OL</sub> = 8mA See Figure 2	IN THE REAL PROPERTY.	0.2	0.8	٧
Positive Going Input Threshold Voltage	V <sub>T+</sub>	Others Ocen	400	1.7	2	V
Negative Going Input Threshold Voltage	V <sub>T</sub> .	(A stol/ equi	0.8	1.1		٧
Input Hysteresis	V <sub>HYS</sub>			0.6		٧
High-Level Input Current	I <sub>IH</sub>	V <sub>IH</sub> = 2V See Figure 2		500		μA
Low-Level Input Current	I <sub>IL</sub>	V <sub>IL</sub> = 0.5V See Figure 2		-500		μА
High-Impedance State Output Current	loz	V <sub>o</sub> = GND See Figure 2			-1	mA
		$V_{o} = V_{cc}$			10	μА
Driver Switching Section (Open-Drain) See	Figure 4	109				
Propagation Delay Time, High to Low	t <sub>PZL</sub>	A CLA		25	40	ns
Propagation Delay Time, Low to High	t <sub>PLZ</sub>	OK //		25	40	ns
Pulse Skew (t <sub>PLZ</sub> - t <sub>PZL</sub> )	t <sub>sk</sub>	See Note 3		4		ns
Rise Time	t <sub>R</sub>	C <sub>1</sub> = 15pF	4	8		ns
Fall Time	t <sub>e</sub>	$C_L = 15pF$	4	8		ns
Driver Switching Section (Totem-Pole) See I	igure 3	_V to 30				
Propagation Delay Time, High to Low	t <sub>PHL</sub>	0140 to 39130	100,000	10	20	ns
Propagation Delay Time, Low to High	t <sub>PLH</sub>	ntsiO martiO		10	20	ns
Pulse Skew (t <sub>PHL</sub> - t <sub>PLH</sub> )	t <sub>sk</sub>	See Note 3			9	ns
Rise Time	t <sub>R</sub>	C <sub>L</sub> = 15pF	4	6		ns
Fall Time		C <sub>1</sub> = 15pF	4	6		ns

Note 3. This specification applies to any 5°C band within the operating temperature range.



# 40MHz Single-Ended Inverting 6-Channel Bus Transceiver

# PRELIMINARY DATA SHEET

Parameter	Symbol	Test Conditions		LX5268		Unit
raidilletei	Syllioui	rest conditions	Min.	Тур.	Max.	Oille.
Receiver Switching Section (See Figure 5)						
Propagation Delay Time, High to Low Level Output	t <sub>PHL</sub>	See Figure 5		10	16	ns
Propagation Delay Time, Low to High Level Output	t <sub>PLH</sub>	See Figure 5		10	16	ns
Enable Time (3-state output) to High Level	t <sub>PZH</sub>		1 10	20	30	ns
Enable Time (3-state output) to Low Level	t <sub>PZL</sub>	10 (01		20	30	ns
Disable Time (3-state output) from High Level	t <sub>PHZ</sub>	100	11 10	20	30	ns
Disable Time (3-state output) from Low Level	t <sub>PLZ</sub>	20 <sup>1</sup> 5901 00	1	20	30	ns
Pulse Skew (t <sub>PHL</sub> - t <sub>PLH</sub> )	t <sub>SK (LIM)</sub>	V <sub>cc</sub> = 5V, See Note 3	erms I me	9	mil/ pritts	ns
Rise Time	t <sub>R</sub>			5	20.02	ns
Fall Time	t <sub>F</sub>		La Trad	5		ns
Rejected Noise Pulse Duration	t <sub>w</sub>			5	- December	ns
Supply Section		THE PERCENT OF THE STATE OF	MILLION DE			
Operating Mode Driver Enabled	I <sub>DD</sub>	No Load, All Inputs Open, CE = V <sub>cc</sub>	100000000000000000000000000000000000000	2	STEE BUIL	mA
Driver Disabled	pentune	No Load, All Inputs Open, CE = V <sub>CC</sub>	25912 120	1	Witness of	mA
Standby Mode	CHES MALES	No Load, All Inputs Open, CE = 0V	STATE OF STREET	100	70 500	μА

### PARAMETER MEASUREMENT INFORMATION

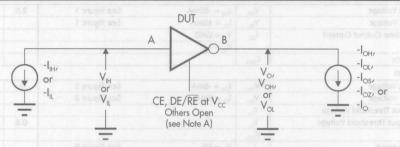


FIGURE 1. — DRIVER TEST CIRCUIT and INPUT CONDITIONS

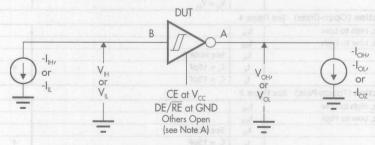


FIGURE 2. — RECEIVER TEST CIRCUIT and INPUT CONDITIONS

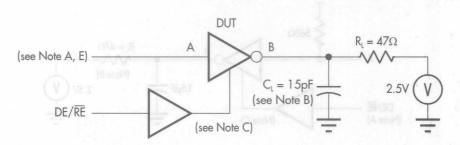
Note A. For the I<sub>oz</sub> test, the CE input is at GND and all other inputs are grounded.



# 40MHz Single-Ended Inverting 6-Channel Bus Transceiver

# PRELIMINARY DATA SHEET

# PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT (Totem Pole)

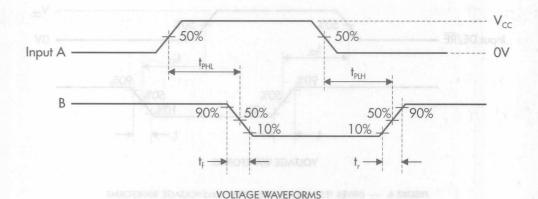


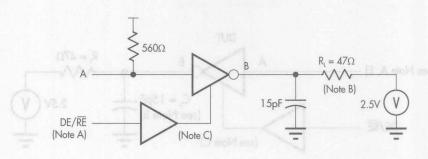
FIGURE 3. — DRIVER TEST CIRCUIT and VOLTAGE WAVEFORMS

Note A. The input pulse is supplied by a generator having the following characteristics: PRR  $\leq$  1MHz, 50% duty cycle, t, & t,  $\leq$  6 ns, and  $Z_{\rm O} = 50\Omega$ .

B.  $C_L$  includes probe and jig capacitance. C. CE is at  $V_{CC}$  and DE is at  $V_{CC}$ .



### PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT

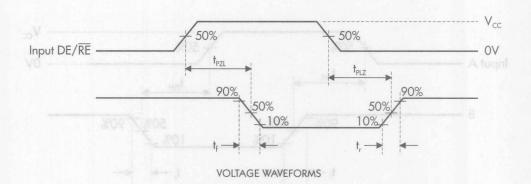


FIGURE 4. — DRIVER TEST CIRCUIT, OPEN DRAIN and VOLTAGE WAVEFORMS

Note A. The input pulse is supplied by a generator having the following characteristics: PRR  $\leq$  1MHz, 50% duty cycle, t, & t,  $\leq$  6 ns, and  $Z_0 = 50\Omega$ .

B. C, includes probe and jig capacitance.

C. CE is at V<sub>cc</sub>.



# 40MHz Single-Ended Inverting 6-Channel Bus Transceiver

# PRELIMINARY DATA SHEET

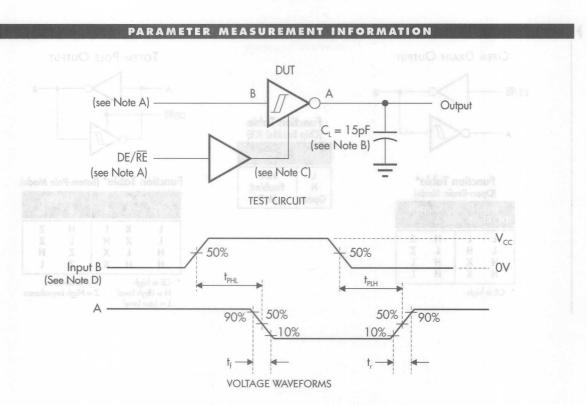


FIGURE 5. — RECEIVER TEST CIRCUIT and VOLTAGE WAVEFORMS

Note A. The input pulse is supplied by a generator having the following characteristics: PRR  $\leq$  1MHz, 50% duty cycle,  $t_r$  &  $t_r \leq$  6 ns, and  $Z_Q = 50\Omega$ .

- B. C, includes probe and jig capacitance.
- C. CE is at V<sub>cc</sub>.
  D. DE/RE is at ground.

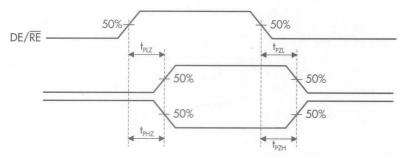
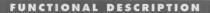


FIGURE 6. — RECEIVER ENABLE DELAY WAVEFORMS

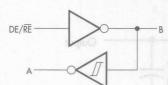


# 40MHz Single-Ended Inverting 6-Channel Bus Transceiver

# PRELIMINARY DATA SHEET



OPEN DRAIN OUTPUT



Function Table\*
(Open-Drain Mode)

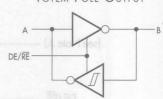
DE	Inp	uts B	Out A	puts B
301	L	L	Н	Z
1	L	Н	L	Z
347	Н	X	Н	L
-A.F	H	X	Н	L

\* CE is high

Function Table (Chip Enable) (CE)

CE	Outputs
L H	Hi Z Enabled
Open	Hi Z

TOTEM POLE OUTPUT



# Function Table\* (Totem-Pole Mode)

In	puts		Out	puts
DE/RE	Α	В	Α	В
L	Х	L	Н	Z
L	X	Н	L	Z
Н	L	X	Z	Н
Н	Н	X	Z	L

CE is high X = H = High Level Z = L = Low Level

X = Irrelevant Z = High Impedance

RIGHTE B. — RECEIVER TEST CIRCUIT and VOLLAGE WAVEFORMS







40MHz Single-Ended 6-Channel Non-Inv. Bus Transceiver

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PRELIMINARY DATA SHEET

#### DESCRIPTION

The LX5269 is a six-channel, non-inverting transceiver that is used to drive and receive the signals from the single-ended Small Computer Systems Interface (SCSI) bus. The totem-pole outputs provide active signal negation for higher signal-tonoise ratios on the bus. All the drivers and receivers may be disabled with the CE control pin. The A inputs of the drivers are taken low to ensure a low on the output when the input is open or to eliminate external pullup resistors. The drivers also feature controlled turn-on and turn-off times to reduce crosstalk in and RF emissions from the SCSI cable.

The LX5269 non-inverting receivers exhibit 600mV of hystersis and incorporates a 5ns pulse filter to reject high-frequency noise coupling from adjacent signal lines. These improvements to typically single-ended SCSI I/O's provide less data errors and higher data throughput with less noise emissions. The DE/RE enable has a pulldown resistor on

the input to ensure that the receiver is enabled when the DE/RE input is open.

The switching speeds of the LX5269 are sufficent to transfer data over the data bus at 80-million transfers per second. Proper bus termination is required to meet these data rates. Linfinity offers a broad range of terminator solutions such as the LX5218, 9-Channel Current Mode Terminator and the LX5208, 18-Channel Boulay Terminator. The pin assignment of the LX5269 and its enabling logic make this device applicable for the data path (8 data bits plus parity) for the SCSI bus.

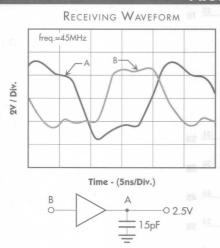
This device is available in the space-efficient shrink-small-outline package (SSOP) with 25-mil pin pitch. Each of the 6 identical channels conform to the requirements of ANSI X3.131 - 1986 (SCSI-1) and the proposed SCSI-2 and -3 standards.

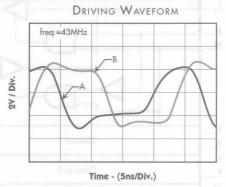
The LX5269 is characterized for operation from 0°C to 70°C.

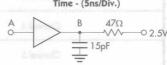
### KEY FEATURES

- OUTPUT CAPACITANCE: 15pF Typ.
- ACTIVE NEGATION (TOTEM-POLE) OR OPEN-DRAIN; SELECTABLE DRIVER OUTPUTS
- TOTEM-POLE; 40mA SOURCE / 48mA SINK CURRENT
- ☐ OPEN-DRAIN; 48mA SINK CURRENT
- ☐ CONTROLLED DRIVER RISE AND FALL TIMES 6ns TYPICAL
- □ LOW SKEW, t<sub>sk (lim)</sub> ... 4ns TYPICAL
- HIGH RECEIVER INPUT VOLTAGE
  HYSTERESIS 600mV typ.
- RECEIVER INPUT NOISE PULSE FILTER 5ns MAXIMUM
- EACH DRIVER AND RECEIVER MEETS ANSI X3.131-1986 (SCSI-1) AND SCSI-2 & 3 STANDARDS
- POWER UP/DOWN GLITCH PROTECTION
- ☐ HIGH IMPEDANCE WITH V., AT 0V
- COMPATIBLE WITH ACTIVE TERMINATORS FROM LINFINITY:
  - LX5218, 9-Channel ULTRA
  - LX5212, 9-Channel Low Capacitance
  - LX5207, 18-Channel Low Capacitance

### PRODUCT HIGHLIGHT







# T<sub>A</sub> (°C) DB Plastic SSOP 36-pin 0 to 70 LX5269CDB

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5269CDBT) For An In-Depth Discussion On Applying SCSI, Request Linfinity Application Note: "Understanding The Single-

Ended SCSI Bus"

FOR FURTHER INFORMATION CALL (714) 898-8121

# 40MHz Single-Ended 6-Channel Non-Inv. Bus Transceiver

# TRANS. ATA WYRA PRELIMINARY DATA SHEET

#### ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage Range (V_)	0.5V to 7V
	0.5V to V <sub>DD</sub> + 0.5V
Data I/O and Control (A-side) Voltage Range	0.5V to $V_{DD} + 0.5V$
	Internally Limited
Operating junction reinperature	
Plastic (DB Package)	150°C
Storage Temperature Range	65°C to 150°C
Lead Temperature (Soldering, 10 seconds)	300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

### THERMAL DATA

#### DB PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT,  $\theta_{j}$ 

80°C/W

Junction Temperature Calculation:  $T_1 = T_A + (P_D \times \theta_A)$ .

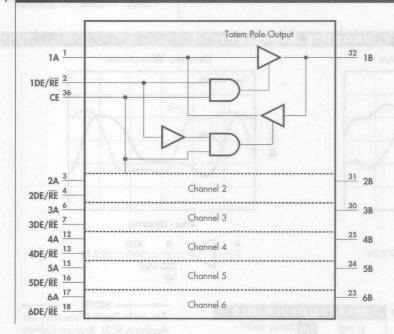
The  $\theta_{J_A}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

### PACKAGE PIN OUTS



**DB PACKAGE** (Top View)

# FUNCTIONAL BLOCK DIAGRAM





# 40MHz Single-Ended 6-Channel Non-Inv. Bus Transceiver

# PRELIMINARY DATA SHEET

	RECOMMENDED	OPERATING C	ONDITIO	<b>NS</b> (Note 2)		
P.		Symbol	Recommen	ded Operating	Conditions	Units
Pal	ameter	Symbol	Min.	Тур.	Max.	Office
Supply Voltage		V <sub>cc</sub>	4.75	5	5.25	V
High-Level Input Voltage		V <sub>IH</sub>	2.0	aver no reve	on Delay Hme, H	٧
Low-Level Input Voltage		V <sub>IL</sub>	dedisc.	Isval right of wo	0.8	V
High-Level Output Current	Driver		Land of	partial upon on the	-40	mA
	Receiver	ОН	100	BADE WELL DE RE	-8	mA
Low-Level Output Current	Driver		100	and the most car	48	mA
	Receiver	lor	Ser Ser Ser	and their town for	8	mA
Operating Virtual Junction Te	emperature Range:	Elatora aas, As = 75,	ment I		Light Jath W	A STANFOLD
LX5269		T <sub>A</sub>	0		125	°C

Note 2. Range over which the device is functional.

### **ELECTRICAL CHARACTERISTICS**

(Unless otherwise specified, these specifications apply over the operating ambient temperatures of  $0^{\circ}C \le T_{_A} \le 70^{\circ}C$ . Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Sumbol	Tost (	Conditions	TO MAKE	LX5269		Unit
Parameter	Symbol	lest (	conditions	Min.	Тур.	Max.	Unit
Driver Section (Totem-Pole)				<b>企業問題</b>			
High-Level Output Voltage	V <sub>OH</sub>	I <sub>OH</sub> = -20mA	See Figure 1	2.0			٧
Low-Level Output Voltage	Vol	I <sub>OL</sub> = 48mA	See Figure 1			0.5	٧
High-Impedance State Output Current	loz	Vo = GND	A			-1	μА
	14	$V_o = V_{cc}$				1	μА
Output Capacitance	C <sub>OUT</sub>			1-1-	15		pF
Receiver Section	101		· Value	10 ( ]			
High-Level Output Voltage	V <sub>OH</sub>	$I_{OH} = -8mA$	See Figure 2	2	3.5		٧
Low-Level Output Voltage	V <sub>OL</sub>	$I_{OL} = 8mA$	See Figure 2	all and discon-	0.2	0.8	٧
Positive Going Input Threshold Voltage	V <sub>T+</sub>	nade saute		-	1.7	2	٧
Negative Going Input Threshold Voltage	V <sub>T</sub>	The pitter may	Participation (Control of Control	0.8	1.1		٧
Input Hysteresis	V <sub>HYS</sub>		4		0.6		٧
High-Level Input Current	I <sub>IH</sub>	$V_{IH} = 2V$	See Figure 2		500		μА
Low-Level Input Current	1 <sub>L</sub>	$V_{IL} = 0.5V$	See Figure 2		-500		μА
High-Impedance State Output Current	loz	$V_o = GND$	See Figure 2			-1	mA
		$V_{o} = V_{cc}$				10	μΑ
Driver Switching Section (Totem-Pole) See	Figure 3	100					
Propagation Delay Time, High to Low	t <sub>PHL</sub>	A			10	20	ns
Propagation Delay Time, Low to High	t <sub>PLH</sub>	177	4		10	20	ns
Pulse Skew (t <sub>PHL</sub> - t <sub>PLH</sub> )	t <sub>sk</sub>	See Note 3		of my		9	ns
Rise Time	t <sub>R</sub>	C <sub>L</sub> = 15pF		4	6		ns
Fall Time	t <sub>e</sub>	C <sub>1</sub> = 15pF	30	4	6		ns

Note 3. This specification applies to any 5°C band within the operating temperature range.



# 40MHz Single-Ended 6-Channel Non-Inv. Bus Transceiver

# PRELIMINARY DATA SHEET

Parameter	Symbol	Test Conditions		LX5269		Units
raidilletei	Symoon	Test conditions	Min.	Тур.	Max.	Office
Receiver Switching Section (See Figure 4)						
Propagation Delay Time, High to Low Level Output	t <sub>PHL</sub>	See Figure 4		10	16	ns
Propagation Delay Time, Low to High Level Output	t <sub>PLH</sub>	See Figure 4		10	16	ns
Enable Time (3-state output) to High Level	t <sub>PZH</sub>	100	C or	20	30	ns
Enable Time (3-state output) to Low Level	t <sub>PZL</sub>	no. no.	SI.	20	30	ns
Disable Time (3-state output) from High Level	t <sub>PHZ</sub>	197	0 1	20	30	ns
Disable Time (3-state output) from Low Level	t <sub>PLZ</sub>	to to the state of	G.	20	30	ns
Pulse Skew (t <sub>PHL</sub> - t <sub>PLH</sub> )	t <sub>SK (LIM)</sub>	V <sub>cc</sub> = 5V, See Note 3	same T o	attonut Isl	9	ns
Rise Time	t <sub>R</sub>			5	988	ns
Fall Time	t <sub>F</sub>	Armony at the others	er is Arrive	5		ns
Rejected Noise Pulse Duration	t <sub>w</sub>			5		ns
Supply Section	ALC: NY	THE PARTY OF THE PARTY OF THE LOSS AND	Male VIII	ANT DAY	1000	
Operating Mode Driver Enabled	I <sub>DD</sub>	No Load, All Inputs Open, CE = V <sub>cc</sub>	St. Market	2	10 10 10	mA
Driver Disabled	Caruffato (	No Load, All Inputs Open, CE = V <sub>CC</sub>	Depth D	1	- Windows	mA
Standby Mode	100000	No Load, All Inputs Open, CE = QV		100		μΑ

# PARAMETER MEASUREMENT INFORMATION

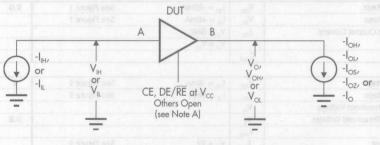


FIGURE 1. — DRIVER TEST CIRCUIT and INPUT CONDITIONS

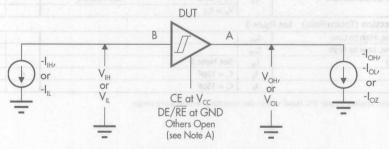


FIGURE 2. — RECEIVER TEST CIRCUIT and INPUT CONDITIONS

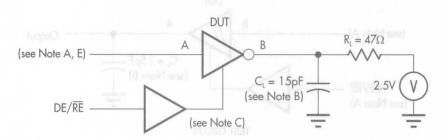
Note A. For the  $I_{\rm oz}$  test, the CE input is at GND and all other inputs are grounded.



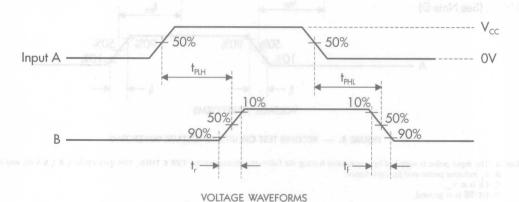
# 40MHz Single-Ended 6-Channel Non-Inv. Bus Transceiver

### PRELIMINARY DATA SHEET

# PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT (Totem Pole)



Note A. The input pulse is supplied by a generator having the following characteristics: PRR  $\leq$  1MHz, 50% duty cycle,  $t_c \& t_f \leq$  6 ns, and  $Z_o = 50\Omega$ .

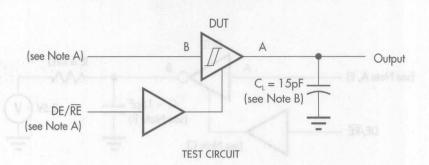
FIGURE 3. — DRIVER TEST CIRCUIT and VOLTAGE WAVEFORMS

B. C<sub>t</sub> includes probe and jig capacitance.

C. CE is at V<sub>cc</sub> and DE is at V<sub>cc</sub>.



### PARAMETER MEASUREMENT INFORMATION



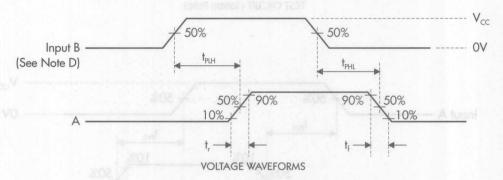


FIGURE 4. — RECEIVER TEST CIRCUIT and VOLTAGE WAVEFORMS

Note A. The input pulse is supplied by a generator having the following characteristics: PRR  $\leq$  1MHz, 50% duty cycle, t, & t,  $\leq$  6 ns, and  $Z_0 = 50\Omega$ .

- B. C, includes probe and jig capacitance.
- C. CE is at  $V_{cc}$ . D. DE/ $\overline{RE}$  is at ground.

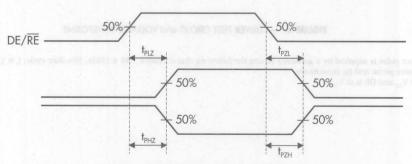


FIGURE 5. — RECEIVER ENABLE DELAY WAVEFORMS



# 40MHz Single-Ended 6-Channel Non-Inv. Bus Transceiver

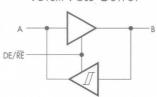
# PRELIMINARY DATA SHEET

# **FUNCTIONAL DESCRIPTION**

# Function Table (Chip Enable) (CE)

CE	Outputs
L	Hi Z
Н	Enabled
Open	Hi Z

TOTEM POLE OUTPUT



# Function Table\* (Totem-Pole Mode)

Inputs			Out	puts
DE/RE	Α	В	A	В
L	Х	L	L	Z
L	X	Н	Н	Z
H	L	Х	Z	L
H	Н	Х	Z	Н

\* CE is high
H = High Level
L = Low Level

X = Irrelevant Z = High Impedance

# Notes

RELIMINARY BAYA SHEET

Function Table\* (Forem-Pale Mada)

X = Irraleyant
Z = High Impedance

CE a high hi = High Level L = Low Level TOTEM POLE OUTPUT



Function Table (Chip Enable) (CE)

Introduction

Quality

**Working With Linfinity** 

**Linfinity Information Network** 

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**Data Communication Circuits** 

**Signal Conditioning Circuits** 

**Motion Control Circuits** 

**Other Linear Circuits** 

**Military Products** 

**Discontinued Products** 

**Package Information** 

Representatives / Distributors

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	SG1503/2503/3503	Precision 2.5V Reference	8-47
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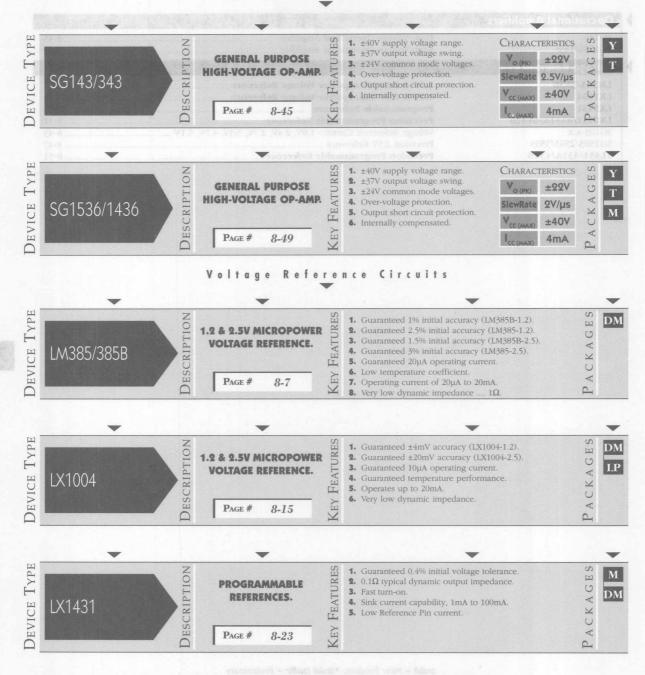
**Bold =** New Product, \***Bold Italic** = Preliminary



# **Selection Guide**

# SIGNAL CONDITIONING PRODUCTS

Operational Amplifiers





# **Selection Guide**

# SIGNAL CONDITIONING PRODUCTS

Voltage Reference Circuits

TYPE DESCRIPTION 1. Unconditionally stable for all cathode to anode DM **PRECISION** capacitance values. CKAG 2. Reduced reference input current. (0.5µA max.) LP **PROGRAMMABLE** 3. Initial voltage reference accuracy of 0.4%. (LX6431B) DEVICE LX6431/A/B REFERENCES. PK 4. Sink current capability 0.6mA to 100mA. 5. Typical output dynamic impedance less than  $100 \text{m}\Omega$ A 6. Adjustable output voltage from 2.5V to 36V. PAGE # 8-31 DEVICE TYPE DESCRIPTION 1. ±10% initial tolerance. (for tighter tolerance contact factory) Z 2. Bandgap design. **VOLTAGE REFERENCE** 0 3. Low dynamic impedance from 10µA to 10mA. CIRCUIT. Y SG103-xx (improved over LM103) × 4. -1mV/°C temperature coefficient. U 5. Output voltages: 1.8V, 2.4V, 2.7V, 3.3V, 4.7V, 5.1V. V 6. Low capacitance. PAGE # 8-43 7. Performance guaranteed over full military temp. range. TYPE DESCRIPTION 1. Bandgap design. ACKAGES 2. Output voltage trimmed to ±1%. 2.5V PRECISION 3. Input voltage range of 4.5V to 40V. **VOLTAGE REFERENCE.** 4. Temperature coefficient of 10ppm/°C DEVICE SG1503/2503/3503 5. Output current in excess of 10mA. M 6. Interchangeable with MC1503 and AD580 DM PAGE # 8-47 TYPE DESCRIPTION 1. Initial voltage reference accuracy of 0.4%. (TL1431) DM **PRECISION** 2. Sink current capability 0.6mA to 100mA. CKAG 3. Typical output dynamic impedance  $< 200 m\Omega$ . LP **PROGRAMMABLE** Typical output dynamic impedance of  $1431 < 100 \text{m}\Omega$ . DEVICE TL431/431A/431E REFERENCES. PK 4. Adjustable output voltage from 2.5V to 36V. 5. Low output noise. 6. Direct pin-to-pin replacement for industry standard Y PAGE # 8-51



TL431 and TL1431.

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# LM385/385B

# 1.2 & 2.5 V MICROPOWER VOLTAGE REFERENCE

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

The LM385/385B Micropower Voltage the overall reference accuracy. References are two terminal bandgap The LM385 family is available in fixed reference diodes designed and optimized for accurate low power operation in portable and other power sensitive systems. Operating currents are guaranteed from as low as 15µA up to 20mA for the LM385/385B-1.2, and 20µA up to 20mA for the LM385/385B-2.5, giving designers a great deal of flexibility in optimizing power consumption, noise and ultimate application performance. As an added feature, the references output impedance is extraordinarily low over the entire operating range of quiescent currents. This enables an extremely wide dynamic load range with little effect on

1.2V and 2.5V reference values. Process and circuit design optimization provide for high accuracy with initial tolerance values of 1% for the LM385B-1.2, 2% for the LM385-1.2, 1.5% for the LM385B-2.5, and 3% for the LM385-2.5. Complementing their initial accuracy, the bandgap reference is temperature compensated to deliver 20ppm performance over the 0° to 70°C operating temperature range.

The LM385 family from Linfinity is a pin-for-pin replacement for the LM385/ 385B family of voltage references.

#### **KEY FEATURES**

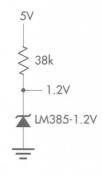
- GUARANTEED 1% INITIAL ACCURACY (LM385B-1.2)
- **■** GUARANTEED 2.5% INITIAL ACCURACY (LM385-1.2)
- GUARANTEED 1.5% INITIAL ACCURACY (LM385B-2.5)
- GUARANTEED 3% INITIAL ACCURACY (LM385-2.5)
- ☐ GUARANTEED 20µA OPERATING CURRENT
- LOW TEMPERATURE COEFFICIENT
- □ OPERATING CURRENT OF 20µA TO 20mA
- $\square$  VERY LOW DYNAMIC IMPEDANCE . . .  $1\Omega$

### APPLICATIONS

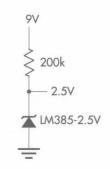
- PORTABLE METER REFERENCES
- PORTABLE TEST INSTRUMENTS
- BATTERY OPERATED SYSTEMS
- ☐ CURRENT LOOP INSTRUMENTATION

#### PRODUCT HIGHLIGHT

1.2V REFERENCE



MICROPOWER REFERENCE FROM 9V BATTERY



	PACK		ER INFORMATI	ON
T <sub>A</sub> (°C)	Reference Voltage	Initial Tolerance	DM Plastic SOIC 8-pin	LP Plastic TO-92 3-pin
	1.01/	±30mV	LM385DM-1.2	LM385LP-2.5
0 - 70	1.2V	±12mV	LM385DM-1.2	LM385BLP-1.2
0 to 70	0.51/	±75mV	LM385DM-2.5	LM385LP-2.5
	2.5V	±38mV	LM385BDM-2.5	LM385BLP-2.5

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LM385DM-2.5T)

FOR FURTHER INFORMATION CALL (714) 898-8121

# LM385/385B

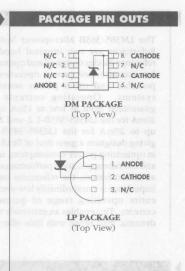
# 1.2 & 2.5 V MICROPOWER VOLTAGE REFERENCE

# TRANS ATA O MOST PRODUCTION DATA SHEET

# 

# THERMAL DATA DM PACKAGE: THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{JA}$ LP PACKAGE: THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{IA}$ 165°C/W

The  $\theta_{JA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.





# 1.2 & 2.5V MICROPOWER VOLTAGE REFERENCE

PRODUCTION DATA SHEET

### **ELECTRICAL CHARACTERISTICS**

(Unless otherwise specified, these specifications apply to  $T_A = 25^{\circ}$ C. Typ number represents  $T_A = 25^{\circ}$ C value.)

### LM385/385B-1.2

Parameter		Comphal	Test Conditions	LM385/385B-1.2			Units
		Syllidoi	Symbol Test Conditions		Тур.	Max.	Units
Reverse Breakdown Voltage	LM385	Vz	$I_{MIN} \le I_R \le I_{MAX}$	1.205	1.235	1.260	٧
	LM385B		$I_{MIN} \le I_R \le I_{MAX}$	1.223	1.235	1.247	٧
Average Temperature Coefficient		$\frac{\Delta V_z}{\Delta Temp}$	$I_R = 100\mu A$		20	ye.	ppm/°C
Minimum Operating Current		I <sub>MIN</sub>			8	15	μA
Reverse Breakdown Voltage Ch	nang	e	$\Delta V_Z$ $I_{MIN} \le I_R \le 1 \text{mA}$			1.5	mV
with Current		$\Delta I_R$	$1mA \le I_R \le 20mA$		V 152	20	mV
Reverse Dynamic Impedance		r <sub>z</sub>	I <sub>R</sub> = 100μA	1000	1		Ω
Wide Band Noise (RMS)		e <sub>n</sub>	$I_R = 100 \mu A$ , $10 Hz \le f \le 10 kHz$	1	60	0	μV
Long Term Stability		$\frac{\Delta V_z}{\Delta Time}$	$I_R = 100\mu\text{A}, T_A = 25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$		20	j.	ppm/kHr

#### LM385/385B-2.5

Parameter		Parameter Symbol Test Conditions		LM385/385B-2.5			Units	
		Sylliooi	lest Conditions		Min.	Тур.	p. Max.	Units
Reverse Breakdown Voltage	LM385	Vz	$I_{MIN} \le I_{R} \le I_{MAX}$		2.425	2.500	2.575	V
	LM385B	ب لنا	$I_{MIN} \le I_R \le I_{MAX}$	A	2.462	2.500	2.538	٧
Average Temperature Coefficient		$\frac{\Delta V_z}{\Delta Temp}$	I <sub>R</sub> = 100μA σεε σος	001 0	. 0	20		ppm/°C
Minimum Operating Current		I <sub>MIN</sub>		Yine - (ps)		13	20	μА
Reverse Breakdown Voltage Ch	ang	е	$\Delta V_{z}$ $I_{MIN} \leq I_{R} \leq 1 \text{mA}$				2	mV
with Current	with Current		$1 \text{mA} \le I_R \le 20 \text{mA}$		3		20	mV
Reverse Dynamic Impedance	Reverse Dynamic Impedance		I <sub>R</sub> = 100μA, f = 20Hz		122	1		Ω
Wide Band Noise (RMS) 14190 334 7A5139MAT		e <sub>n</sub>	$I_R = 100\mu A$ , $10Hz \le f \le 10kHz$	CHARACTERISTICS	DRWARE	120	B BRUBI	μV
Long Term Stability		ΔV <sub>Z</sub>	$I_R = 100 \mu A, T_A = 25^{\circ} C \pm 0.1^{\circ} C$			20	8.7	ppm/kHr
		ΔTime					121	3.0

# GRAPH / CURVE INDEX

# Characteristic Curves LM385/385B-1.2

### FIGURE #

- 1. RESPONSE TIME
- 2. REVERSE CHARACTERISTICS
- 3. FORWARD CHARACTERISTICS
- 4. TEMPERATURE DRIFT
- 5. REVERSE VOLTAGE CHANGE
- 6. REVERSE DYNAMIC IMPEDANCE
- 7. NOISE VOLTAGE

# Characteristic Curves LM385/385B-2.5

### FIGURE #

- 8. RESPONSE TIME
- 9. REVERSE CHARACTERISTICS
- 10. FORWARD CHARACTERISTICS
- 11. TEMPERATURE DRIFT
- 12. REVERSE DYNAMIC IMPEDANCE
- 13. NOISE VOLTAGE



### PRODUCTION DATA SHEET

# CHARACTERISTIC CURVES - LM385/385B-1.2V

FIGURE 1. — RESPONSE TIME

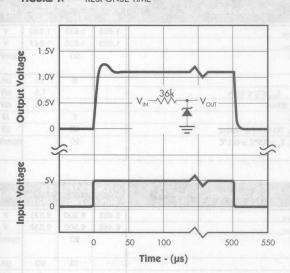


FIGURE 2. — REVERSE CHARACTERISTICS

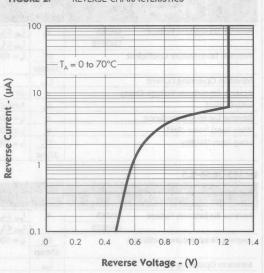


FIGURE 3. — FORWARD CHARACTERISTICS

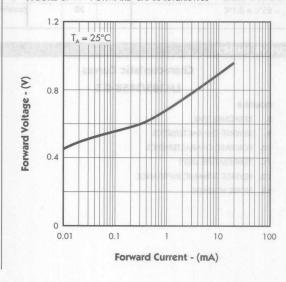
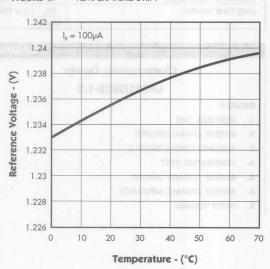


FIGURE 4. — TEMPERATURE DRIFT





# 1.2 & 2.5 V MICROPOWER VOLTAGE REFERENCE

PRODUCTION DATA SHEET

# CHARACTERISTIC CURVES — LM385/385B-1.2V

FIGURE 5. — REVERSE VOLTAGE CHANGE

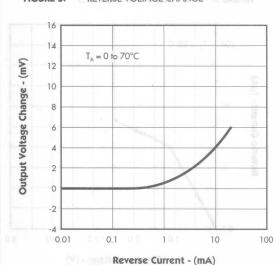


FIGURE 6. — REVERSE DYNAMIC IMPEDANCE

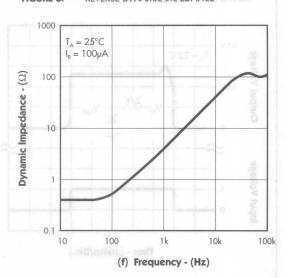
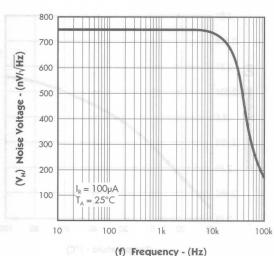


FIGURE 7. — NOISE VOLTAGE



1.0
1.0
1.0
1.0
1.0
1.0
0.0
0.0
0.0
0.0

y - (Hz) (Ast) - manal know

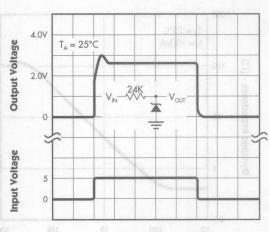
# LM385/385B

# 1.2 & 2.5V MICROPOWER VOLTAGE REFERENCE

PRODUCTION DATA SHEET

# CHARACTERISTIC CURVES — LM385/385B-2.5V

FIGURE 8. — RESPONSE TIME



Time - (100µs/Div.)

FIGURE 9. — REVERSE CHARACTERISTICS

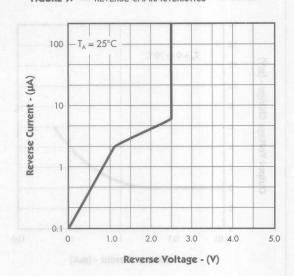


FIGURE 10. — FORWARD CHARACTERISTICS

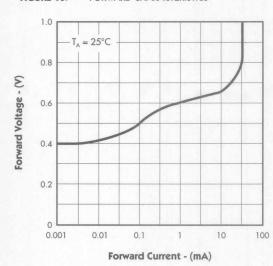
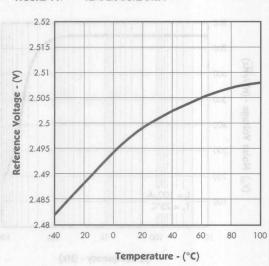


FIGURE 11. — TEMPERATURE DRIFT





# 1.2 & 2.5 V MICROPOWER VOLTAGE REFERENCE

# PRODUCTION DATA SHEET

# CHARACTERISTIC CURVES - LM385/385B-2.5V

FIGURE 12. — REVERSE DYNAMIC IMPEDANCE

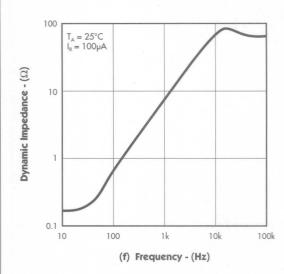
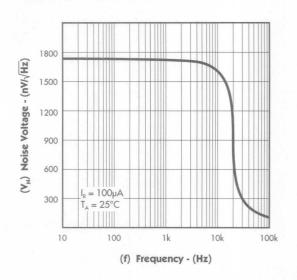
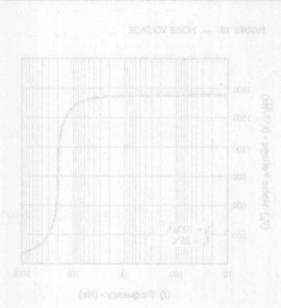


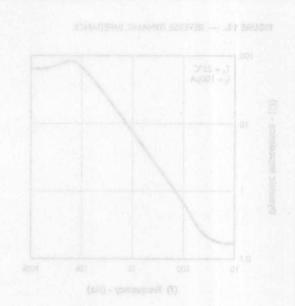
FIGURE 13. — NOISE VOLTAGE



# Notes

TRABE ATAR KOTTORORS











# 1.2V & 2.5V MICROPOWER VOLTAGE REFERENCES

THE INFINITE POWER OF INNOVATION PRODUCTION DATA SHEET

### DESCRIPTION

The LX1004 Micropower Voltage References are two terminal bandgap reference diodes designed and optimized for accurate low power operation in portable and other power sensitive systems. Operating currents are guaranteed from as low as 10µA up to 20mA giving designers a great deal of flexibility in optimizing power consumption, noise and ultimate application performance.

The LX1004 is available in fixed 1.2V and 2.5V reference values.

Process and circuit design optimization provide for high accuracy with initial tolerance values of ±4mV and ±20mV, respectively. Complementing their initial accuracy, the bandgap reference is temperature compensated to deliver 20ppm performance over the 0° to 70°C operating temperature range.

The LX1004 from Linfinity is a pinfor-pin replacement for the LT1004 and LM385 families of voltage references

#### **KEY FEATURES**

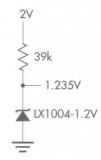
- GUARANTEED ±4mV INITIAL ACCURACY LX1004-1.2
- GUARANTEED ±20mV INITIAL ACCURACY LX1004-2.5
- GUARANTEED 10µA OPERATING CURRENT
- GUARANTEED TEMPERATURE PERFORMANCE
- OPERATES UP TO 20mA
- VERY LOW DYNAMIC IMPEDANCE

# APPLICATIONS

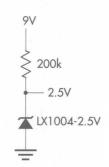
- **PORTABLE METER REFERENCES**
- PORTABLE TEST INSTRUMENTS
- BATTERY OPERATED SYSTEMS
- CURRENT LOOP INSTRUMENTATION

# PRODUCT HIGHLIGHT

MICROPOWER REFERENCE FROM 2 CELL BATTERY



MICROPOWER REFERENCE FROM 9V BATTERY



	PACKA	GE OR	DER INFORMA	TION
T <sub>A</sub> (°C)	Reference Voltage	Initial Tolerance	DM Plastic SOIC 8-pin	LP Plastic TO-92 3-pin
0 - 70	1.2V	±4mV	LX1004CDM-1.2	LX1004CLP-1.2
0 to 70	2.5V	±20mV	LX1004CDM-2.5	LX1004CLP-2.5

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX1004CDM-2.5T)

FOR FURTHER INFORMATION CALL (714) 898-8121

# 1.2V & 2.5V MICROPOWER VOLTAGE REFERENCES

# THE REAL ROLL PRODUCTION DATA SHEET TO REPORT STREET

# ABSOLUTE MAXIMUM RATINGS (Note 1)

Reverse Breakdown Current	
Forward Current	
Operating Temperature Range	0°C to 70°C
Storage Temperature Range	65°C to 150°C
Lead Temperature (soldering, 10 seconds)	300°C

Note 1. Values beyond which damage may occur. All voltages are specified with respect to ground, and all currents are positive into the specified terminal

### THERMAL DATA

DM PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ,

165°C/W

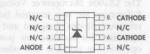
P PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT,  $\theta_{IA}$ 

165°C/W

The  $\theta_{j_A}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

### PACKAGE PIN OUTS



DM PACKAGE (Top View)



LP PACKAGE (Top View)

MICROPOWER RAFERINGS



# 1.2V & 2.5V MICROPOWER VOLTAGE REFERENCES

### PRODUCTION DATA SHEET

# ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply to  $T_A = 25^{\circ}$ C for LX1004C. Typ. number represents  $T_A = 25^{\circ}$ C value.

### LX1004 - 1.2

	Complete	Took Conditions	LX1004 - 1.2			Units
Parameter	Symbol	Test Conditions	Min.	Тур.	Max.	Units
Reverse Breakdown Voltage	V <sub>7</sub>	I <sub>R</sub> = 100μA, T <sub>A</sub> = 25°C	1.231	1.235	1.239	٧
		0°≤ T <sub>A</sub> ≤ 70°C	1.225	1.235	1.245	٧
Average Temperature Coefficient	$\Delta V_z$ $\Delta Temp$	$I_{MIN} \le I_{R} \le 20 \text{mA}$		20	ATE TO SERVICE	ppm/°C
Minimum Operating Current	I <sub>MIN</sub>	0°≤ T <sub>A</sub> ≤ 70°C		8	10	μA
Reverse Breakdown Voltage Change	- E OF	$I_{MIN} \le I_R \le 1 \text{mA}, T_A = 25^{\circ}\text{C}$			1	mV
with Current	$\Delta V_z$	$I_{MIN} \le I_R \le 1 \text{ mA}, 0^\circ \le T_A \le 70^\circ \text{C}$			1.5	mV
	$\Delta I_R$	$1 \text{mA} \le I_R \le 20 \text{mA}, T_A = 25 ^{\circ} \text{C}$		1 4 9	10	mV
		$1 \text{ mA} \le I_R \le 20 \text{ mA}, 0^\circ \le T_A \le 70^\circ \text{C}$		100	20	mV
Reverse Dynamic Impedance	r,	I <sub>s</sub> = 100μA, T <sub>A</sub> = 25°C		0.2	0.6	Ω
		$I_{R} = 100 \mu A, 0^{\circ} \le T_{A} \le 70^{\circ} C$			1.5	Ω
Wide Band Noise (RMS)	en	$I_{R} = 100 \mu A; 10 Hz \le f \le 10 kHz$		60		μV
Long Term Stability	$\Delta V_z$ $\Delta Time$	$I_R = 100 \mu A; T_A = 25^{\circ}C \pm 0.1^{\circ}C$		20	1,23	ppm/kHr

#### LX1004 - 2.5

Parameter	Symbol	Test Conditions	LX	1004 - 2	2.5	Units
Farameter	Sylliooi	lest Conditions		Тур.	Max.	Units
Reverse Breakdown Voltage	V <sub>z</sub>	I <sub>R</sub> = 100μA, T <sub>A</sub> = 25°C	2.480	2.500	2.520	V
(A) - allerton person		0°≤ T <sub>A</sub> ≤ 70°C	2.470		2.530	٧
Average Temperature Coefficient	$\frac{\Delta V_z}{\Delta Temp}$	$I_{MIN} \le I_{R} \le 20mA$		20		ppm/°C
Minimum Operating Current	I <sub>MIN</sub>	0°≤ T <sub>A</sub> ≤ 70°C		12	20	μA
Reverse Breakdown Voltage Change	- 4-27	$I_{MIN} \le I_R \le 1 \text{mA}, T_A = 25 ^{\circ}\text{C}$	A BENEA	图 — .	11	mV
with Current	$\Delta V_z$	$I_{MIN} \le I_R \le 1 \text{mA}, 0^\circ \le T_A \le 70^\circ \text{C}$			1.5	mV
	$\Delta I_R$	$1 \text{mA} \le I_R \le 20 \text{mA}, T_A = 25 ^{\circ} \text{C}$	anning bearing		10	mV
		$1 \text{mA} \le I_R \le 20 \text{mA}, 0^\circ \le T_A \le 70^\circ \text{C}$			20	mV
Reverse Dynamic Impedance	r,	$I_R = 100 \mu A, T_A = 25 ^{\circ} C$		0.2	0.6	Ω
		$I_R = 100 \mu A, 0^{\circ} \le T_A \le 70^{\circ} C$	ZV-GFU =	X _	1.5	Ω
Wide Band Noise (RMS)	e <sub>n</sub>	$I_R = 100 \mu A; 10 Hz \le f \le 10 kHz$		120		μV
Long Term Stability	$\Delta V_z$	$I_R = 100 \mu A; T_A = 25 ^{\circ} C \pm 0.1 ^{\circ} C$		20	01	ppm/kHr
	ΔTime					18

# GRAPH / CURVE INDEX

### Characteristic Curves — LX1004-1.2V

#### FIGURE #

- 1. TEMPERATURE DRIFT
- 2. REVERSE CHARACTERISTICS
- 3. REVERSE VOLTAGE CHANGE
- 4. FORWARD CHARACTERISTICS
- 5. REVERSE DYNAMIC IMPEDANCE
- 6. NOISE VOLTAGE
- 7. RESPONSE TIME

### Characteristic Curves — LX1004-2.5V

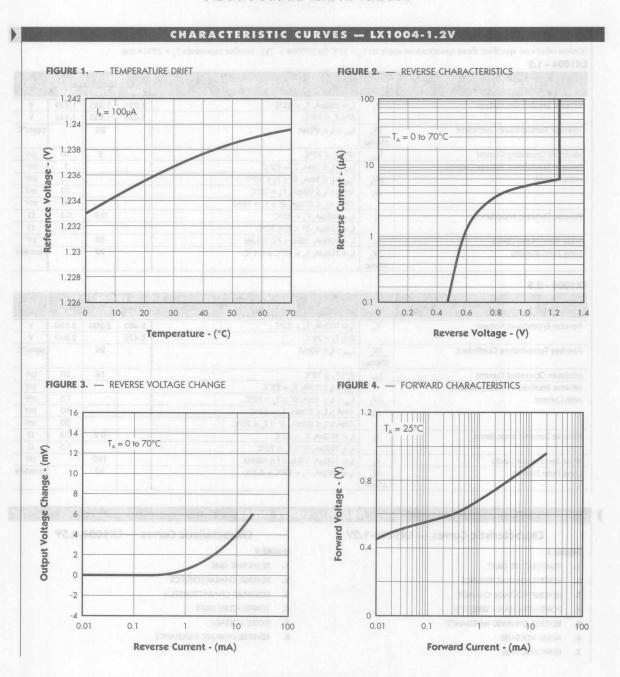
#### FIGURE #

- 1. RESPONSE TIME
- 2. REVERSE CHARACTERISTICS
- 3. FORWARD CHARACTERISTICS
- 4. TEMPERATURE DRIFT
- 5. NOISE VOLTAGE
- 6. REVERSE DYNAMIC IMPEDANCE



#### 1.2V & 2.5V MICROPOWER VOLTAGE REFERENCES

PRODUCTION DATA SHEET



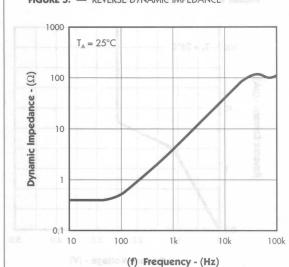


## 1.2V & 2.5V MICROPOWER VOLTAGE REFERENCES

PRODUCTION DATA SHEET

#### CHARACTERISTIC CURVES - LX1004-1.2V

FIGURE 5. — REVERSE DYNAMIC IMPEDANCE



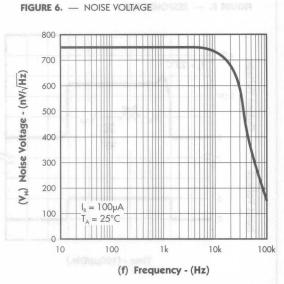
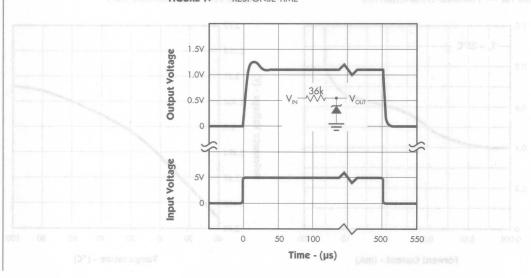


FIGURE 7. — RESPONSE TIME



#### 1.2V & 2.5V MICROPOWER VOLTAGE REFERENCES

#### PRODUCTION DATA SHEET

#### CHARACTERISTIC CURVES - LX1004-2.5V

FIGURE 8. — RESPONSE TIME

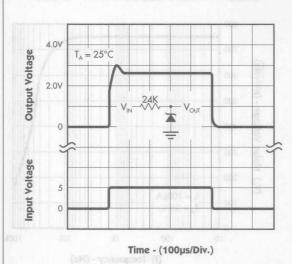
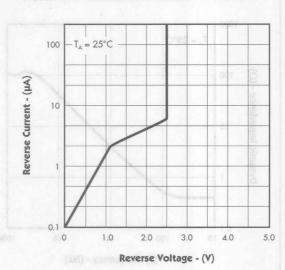


FIGURE 9. — REVERSE CHARACTERISTICS



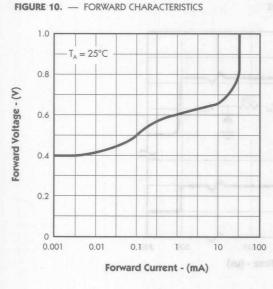
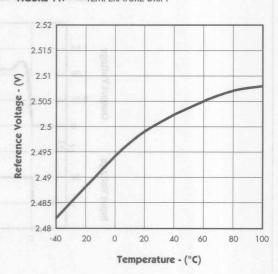


FIGURE 11. — TEMPERATURE DRIFT





## 1.2V & 2.5V MICROPOWER VOLTAGE REFERENCES

PRODUCTION DATA SHEET

#### CHARACTERISTIC CURVES - LX1004-2.5V

FIGURE 12. — NOISE VOLTAGE

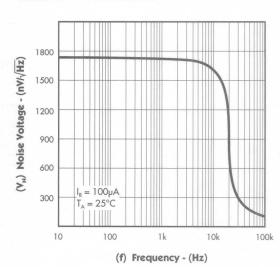
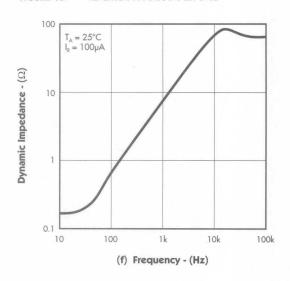
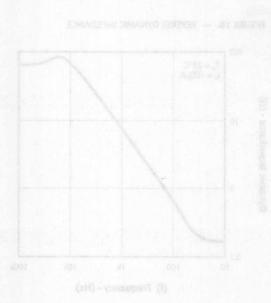
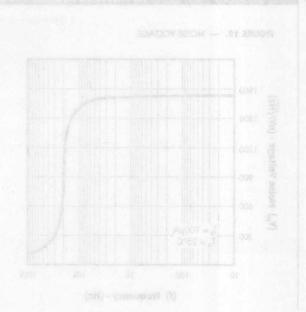


FIGURE 13. — REVERSE DYNAMIC IMPEDANCE













#### PROGRAMMABLE REFERENCE

THE INFINITE POWER OF INNOVATION PRODUCTION DATA SHEET

#### DESCRIPTION

The LX1431 is an adjustable shunt voltage regulator featuring 100mA sink capability, a 0.4% initial reference voltage tolerance and a 0.3% typical temperature stability. This product, which is ideal for use in Pentium® applications, is equipped with on-chip divider resistors, enabling it to be configured as a 5V shunt regulator. In this configuration, the LX1431 has an initial voltage tolerance of only 1% and requires no additional external components. The Linfinity LX1431EB evaluation board and design kit is available to assist engineers in quickly configuring the most efficient, cost-effective Pentium designs.

The output voltage of the LX1431 may be set to any value between 2.5V and 36V through the addition of two external resistors, which is of particular importance in the design of both adjustable and switching power supplies. In addition, the nominal internal current limit of 100mA may be decreased with the addition of a single external resistor.

For applications requiring an adjustable reference, the Linfinity LX6431CLP, a simplified three-pin programmable reference, may be used. Because the LX6431 is pin-for-pin compatible with Linfinity's earlier TL431, use of this product provides designers a simple migration path to the more robust LX6431. A separate LX6431 data sheet is available which details the specifics of this product.

In addition, Pentium designers may use Linfinity's LX8585/8585A 4.6A or LX8584/ 8584A 7A Low Dropout Regulators to achieve the most optimum motherboard configura-

#### KEY FEATURES

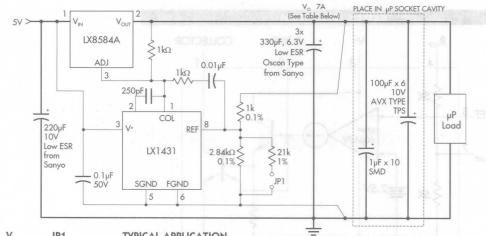
- ☐ GUARANTEED 0.4% INITIAL VOLTAGE TOLERANCE
- □ 0.1Ω TYPICAL DYNAMIC OUTPUT **IMPEDANCE**
- ☐ FAST TURN-ON
- SINK CURRENT CAPABILITY, 1mA TO 100mA
- LOW REFERENCE PIN CURRENT

#### APPLICATIONS

- LINEAR REGULATORS
- ADJUSTABLE POWER SUPPLIES
- SWITCHING POWER SUPPLIES
- LX1431EB EVALUATION BOARD FOR PENTIUM APPLICATIONS AVAILABLE. CONSULT FACTORY.

#### PRODUCT HIGHLIGHT

THE LX8584A AND LX1431 IN 75 AND 166MHz P54C PROCESSOR APPLICATIONS USING 3.3V CACHE



JP1 3.50 Short 3.38 Open TYPICAL APPLICATION

120/166MHz, VRE, 3.3V Cache 75/90/100/133MHz, STND, 3.3V Cache

Thick traces represent high current traces which must be low resistance / low inductance traces in order to achieve good transient response.

Н	PACK	AGE ORDER	INFORMATION
	T <sub>A</sub> (°C)	M Plastic DIP 8-pin	DM Plastic SOIC 8-pin
	0 to 70	LX1431CM	LX1431CDM
	-40 to 85	LX1431IM	LX1431IDM

Note: All surface mount packages are available in Tape & Reel. Append the letter "T" to part number (i.e. LX1431CDMT).

#### FOR FURTHER INFORMATION CALL (714) 898-8121

#### PROGRAMMABLE REFERENCE

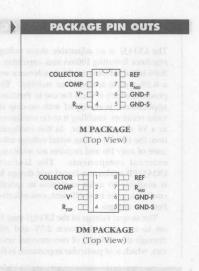
#### PRODUCTION DATA SHEET

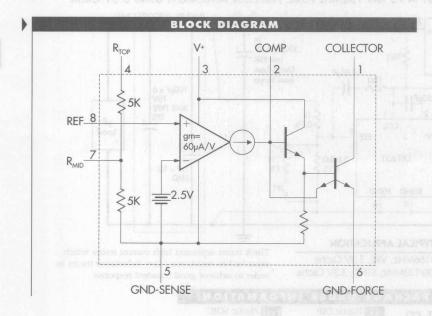
# ABSOLUTE MAXIMUM RATINGS (Note 1) V\*, V<sub>COLLECTOR</sub> 36V V<sub>COMP</sub>, R<sub>TOP</sub>, R<sub>MD</sub>, V<sub>REF</sub> 6V GND-F to GND-S 0.7V Operating Junction Temperature Plastic (M, DM Packages) 150°C Storage Temperature Range -65°C to 150°C Lead Temperature 300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

# THERMAL DATA M PACKAGE: THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{\rm JA}$ DM PACKAGE: THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{\rm JA}$ 165°C/W

Junction Temperature Calculation:  $T_j = T_A + (P_D x \theta_{JA})$ . The  $\theta_{JA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.







#### PROGRAMMABLE REFERENCE

#### PRODUCTION DATA SHEET

#### **ELECTRICAL CHARACTERISTICS**

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for LX1431C with 0°C  $\leq T_A \leq 70$ °C, LX1431I with -40°C  $\leq T_A \leq 85$ °C.)

Payamata.	Cumbal	Tost Conditions	LX1431I			LX1431C			Units
Parameter	Symbol	Test Conditions		Min. Typ. Max.		Min.	Min. Typ. Max.		Units
Reference Voltage	e ed Jem,	$V_{KA} = 5V$ , $I_{K} = 2mA$ , $T_{A} = 25^{\circ}C$	2490	2500	2510	2490	2500	2510	mV
	V <sub>REF</sub>	$V_{KA} = 5V$ , $I_K = 2mA$	2465		2535	2480	193.13	2520	mV
Reference Drift	$\Delta V_{REF}/\Delta T$	$V_{KA} = 5V$ , $I_K = 2mA$		50			30		ppm/°C
Voltage Ratio, Reference to Cathode (Open Loop Gain)	$\frac{\Delta V_{REF}}{\Delta V_{KA}}$	$I_K = 2mA$ , $V_{KA} = 3V$ to 36V	ind an	0.2	1.0	Isno	0.2	1.0	mV/V
Reference Input Current	[I <sub>REF</sub> ]	$V_{KA} = 5V, T_A = 25^{\circ}C$ $V_{VA} = 5V$		0.2	1 1.5	ESPOLIS	0.2	1.2	μА
Minimum Operating Current	I <sub>MIN</sub>	$V_{KA} = V_{REF}$ to 36V, $T_A = 25^{\circ}$ C	DE	0.6	1	min st.	0.6	1	mA
Off-State Cathode Current	A BU HURI	$V_{KA} = 36V, V_{REF} = 0V, T_A = 25^{\circ}C$		m1 3/2	1	maline	(a)	1	μА
	[l <sub>OFF</sub> ]	$V_{KA} = 36V, V_{REF} = 0V$	100 10	- Constant	15	CV2	e)	2	μА
Off-State Collector Leakage Current	ada no es	$V_{COLL} = 36V, V^{+} = 5V, V_{REF} = 2.4V, T_{A} = 25^{\circ}C$			1			1	μA
	[I <sub>LEAK</sub> ]	$V_{COLL} = 36V, V^{+} = 5V, V_{REF} = 2.4V$	n siz-	ilė lait	5	udi lo	do la	2	μА
Dynamic Impedance	$[Z_{KA}]$	$V_{KA} = V_{REF}$ , $I_{K} = 1$ mA to 100mA, $f \le 1$ kHz, $I_{A} = 25$ °C	er vier	PETSON	0.1	HTLESS	196.3	0.1	Ω
Collector Current Limit	I <sub>IIM</sub>	$V_{KA} = V_{REF} + 50 \text{mV}$	80	lai cin	360	100	Lemal	360	mA
5V Reference Output	my requi	Internal Divider Used, I <sub>K</sub> = 2mA, T <sub>A</sub> = +25°C	4950	5000	5050	4950	5000	5050	mV

The con feedback to

GOLL pin reduces the 3t imper frequency response, thereby de-

connection for the dia.

Pla 7 R<sub>van</sub>: Niddle of the on chip resistive divider string between R<sub>van</sub> and GNDs. The gin is sed to REF for self-

Pin 8 REF: Control pin of the durat regulator with a 2.5V (Inceirold).

#### APPLICATION INFORMATION

#### PIN FUNCTIONS

**Pin 1 COLL:** Open collector of the output transistor. The maximum pin voltage is 36V. The saturation voltage at 100mA is approximately 1V.

**Pin 2 COMP:** Base of the driver for the output transistor. This pin allows additional compensation for complex feedback systems and shutdown of the regulator. It must be left open if unused.

**Pin 3 V\*:** Bias voltage for the entire shunt regulator. The maximum input voltage is 36V and the minimum to operate is equal to  $V_{\text{NFF}}$  (2.5V). The quiescent current is typically 0.6mA.

**Pin 4 R**<sub>rop</sub>: Top of the on-chip 5k-5k resistive divider that guarantees 1% accuracy of operation as a 5V shunt regulator with no external trim. The pin is tied to COLL for self-contained 5V operation. It may be left open if unused.

**Pin 5 GND-S:** Ground reference for the on-chip resistive divider and shunt regulator circuitry except for the output transistor. This pin allows external current limit of the output transistor with one resistor between GND-F (force) and GND-S (sense).

**Pin 6 GND-F:** Emitter of the output transistor and substrate connection for the die.

**Pin 7**  $R_{MID}$ : Middle of the on-chip resistive divider string between  $R_{TOP}$  and GND-S. The pin is tied to REF for self-contained 5V operation. It may be left open if unused.

**Pin 8 REF:** Control pin of the shunt regulator with a 2.5V threshold.

COMP,  $R_{TOP}$ ,  $R_{MID}$ , and REF have static discharge protection circuits that must not be activated on a continuous basis. Therefore, the absolute maximum DC voltage on these pins is 6V, well beyond the normal operating conditions.

As with all bipolar ICs, the LX1431 contains parasitic diodes which must not be forward biased or else anomalous behavior will result. Pin conditions to be avoided are RTOP below RMID in voltage and any pin below GND-F in voltage (except for GND-S).

#### FREQUENCY COMPENSATION

Excess capacitance on the REF pin can introduce enough phase shift to induce oscillation when configured as a reference >2.5V. This can be compensated with capacitance between COLL and REF (phase lead). More complicated feedback loops may require shaping of the frequency response of the LX1431 with dominant pole or pole-zero compensation. This can be accomplished with a capacitor or series resistor and capacitor between COLL and COMP.

The compensation schemes mentioned above use voltage feedback to stabilize the circuits. There must be voltage gain at the COLL pin for them to be effective, so the COLL pin must see a reasonable AC impedance. Capacitive loading of the COLL pin reduces the AC impedance, voltage gain, and frequency response, thereby decreasing the effectiveness of the compensation schemes, but also decreasing their necessity.



#### PROGRAMMABLE REFERENCE

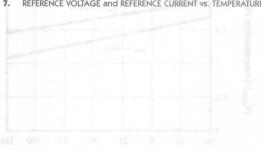
#### PRODUCTION DATA SHEET

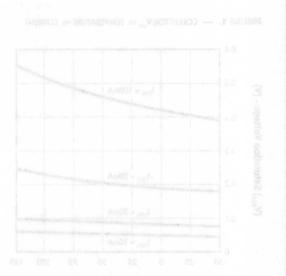
#### **GRAPH / CURVE INDEX**

#### **Characteristic Curves**

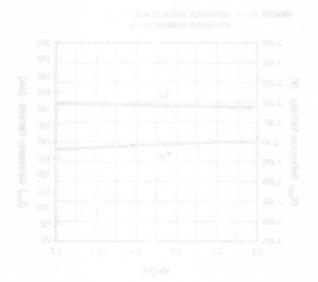
#### FIGURE #

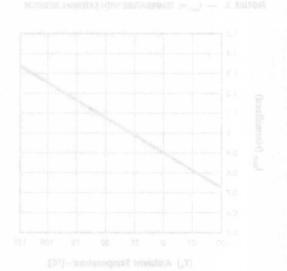
- 1. COLLECTOR V<sub>SAT</sub> vs. TEMPERATURE vs. CURRENT
- 2. COMPENSATION PIN VOLTAGE vs. TEMPERATURE vs. I COLL
- 3. I<sub>LIMIT</sub> vs. TEMPERATURE WITH EXTERNAL RESISTOR
- 4. REFERENCE VOLTAGE and REFERENCE CURRENT vs. V+
- 5. REFERENCE VOLTAGE and REFERENCE CURRENT vs. V+
- 6. 2.5V REFERENCE IK VS. VKA
- REFERENCE VOLTAGE and REFERENCE CURRENT vs. TEMPERATURE













#### PROGRAMMABLE REFERENCE

#### PRODUCTION DATA SHEET

#### CHARACTERISTIC CURVES

FIGURE 1. — COLLECTOR V<sub>SAT</sub> vs. TEMPERATURE vs. CURRENT

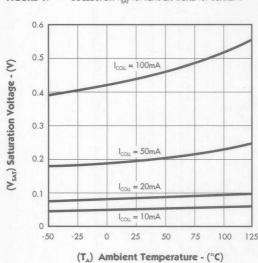
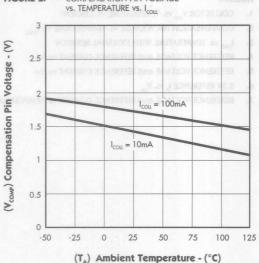


FIGURE 2. — COMPENSATION PIN VOLTAGE



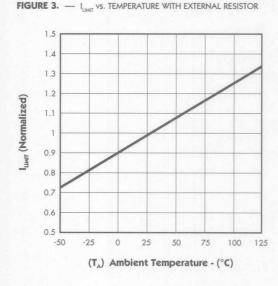
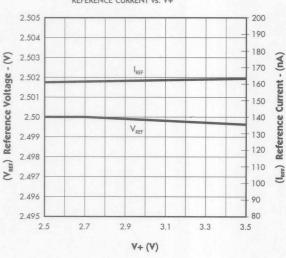


FIGURE 4. — REFERENCE VOLTAGE and REFERENCE CURRENT vs. V+





#### PROGRAMMABLE REFERENCE

#### PRODUCTION DATA SHEET

#### CHARACTERISTIC CURVES

FIGURE 5. — REFERENCE VOLTAGE and

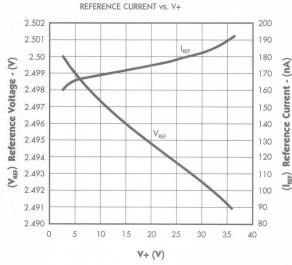


FIGURE 6. — 2.5V REFERENCE IK VS. VKA

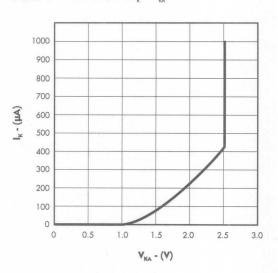
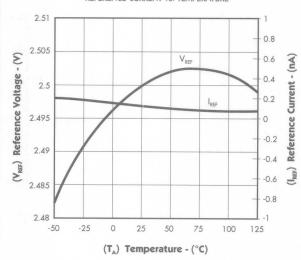
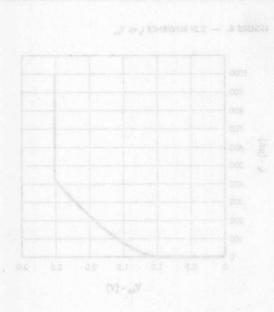
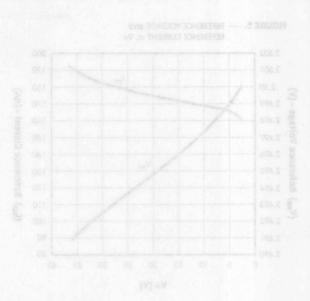


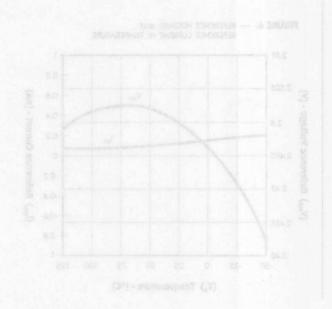
FIGURE 6. — REFERENCE VOLTAGE and REFERENCE CURRENT vs. TEMPERATURE



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PRECISION PROGRAMMABLE REFERENCES

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#### DESCRIPTION

The LX6431 series precision adjustable three terminal shunt voltage regulators are pin-to-pin compatible with the industry standard TL431, but with significant improvements. The LX6431 design has eliminated regions of instability common to older generation shunt regulator products like the TL431. Designs are made simpler by eliminating the task of insuring capacitive loads, and output voltage and cathode currents don't combine for unstable operation. The capacitor value is chosen simply to give the best load transient response without the possibility of instability. A lower reference input current allows the use of higher value reference divider resistors,

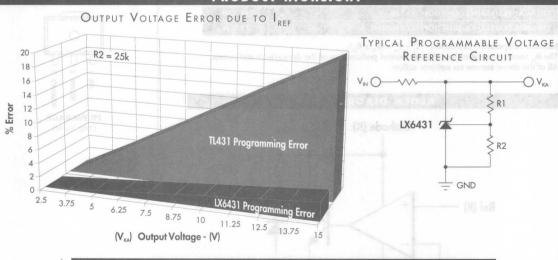
reducing the current drain from batteries in portable equipment as well as reducing the voltage programming errors due to the impedance of the divider network (See Product Highlight figure below). In addition, the LX6431B has an improved initial accuracy of 0.4%, and the output voltage is programmable by using two external resistors from 2.5V to 36V.

These devices offer low output impedance for improved load regulation. The typical output impedance of these devices is  $100 \text{m}\Omega$ . The reduced reference input bias current and minimum operating currents make these devices suitable for portable and micropower applications.

#### KEY FEATURES

- UNCONDITIONALLY STABLE FOR ALL CATHODE TO ANODE CAPACITANCE VALUES
- REDUCED REFERENCE INPUT CURRENT ALLOWING THE USE OF HIGHER VALUE DIVIDER RESISTORS (0.5µA max.)
- INITIAL VOLTAGE REFERENCE ACCURACY OF 0.4% (LX6431B)
- SINK CURRENT CAPABILITY 0.6mA to 100mA
- TYPICAL OUTPUT DYNAMIC IMPEDANCE LESS THAN 100mΩ
- ADJUSTABLE OUTPUT VOLTAGE FROM 2.5V

#### PRODUCT HIGHLIGHT



200000000000000000000000000000000000000	THE R. P. LEWIS CO., LANSING, MICH.	THE RESIDENCE OF THE PARTY OF T	RINFORMATIC	SESSION NEWSFILM
T <sub>A</sub> (°C)	Initial Tolerance	DM Plastic SOIC 8-pin	LP Plastic TO-92 3-pin	PK Plastic SOT-89 3-pin
	2%	LX6431CDM	LX6431CLP	LX6431CPK
0 to 70	1%	LX6431ACDM	LX6431ACLP	LX6431ACPK
	0.4%	LX6431BCDM	LX6431BCLP	LX6431BCPK
	2%	LX6431IDM	LX6431ILP	LX6431IPK
-40 to 85	1%	LX6431AIDM	LX6431AILP	LX6431AIPK
	0.4%	LX6431BIDM	LX6431BILP	LX6431BIPK

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. LX5212CDPT) TO-92 (LP) package also available in ammo-pack.

#### FOR FURTHER INFORMATION CALL (714) 898-8121

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#### ABSOLUTE MAXIMUM RATINGS (Note 1)

Cathode to Anode Voltage (V <sub>vA</sub> )	0.3V to 37V
and a strength of the strength	THE THEORY STITUTED IN THE PROPERTY OF
	-100mA to 150mA
	instruction of the second seco
Storage Temperature Range	65°C to 150°C
Lead Temperature	300°C

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal. Pin numbers refer to DIL packages only.

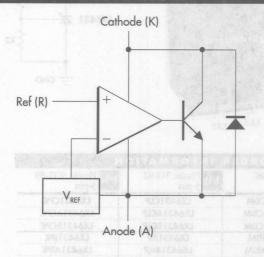
#### THERMAL DATA

#### DA DACKAGE

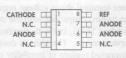
DM PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{JA}}$	165°C/W
LP PACKAGE:	
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{\mathrm{JA}}}$	156°C/W
PK PACKAGE:	ELL TOURS
THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{_{\mathrm{JT}}}$	35°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ	71°C/W

Junction Temperature Calculation:  $T_J = T_A + (P_D \ x \ \theta_{JA})$ . The  $\theta_{IA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow

#### BLOCK DIAGRAM



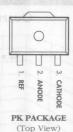
#### **PACKAGE PIN OUTS**



DM PACKAGE (Top View)



LP PACKAGE (Top View)



#### PRECISION PROGRAMMABLE REFERENCES

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#### ELECTRICAL CHARACTERISTICS (Note 2)

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for LX6431C/LX6431AC/LX6431BC with  $0^{\circ}\text{C} \leq T_{A} \leq 70^{\circ}\text{C}$ , LX6431I/LX6431BI with  $-40^{\circ}\text{C} \leq T_{A} \leq 85^{\circ}\text{C}$ .)

Parameter State of the State of		Cumbal	Combal Task Candidians		LX6431		
Parameter		Symbol	Test Conditions	Min.	Тур.	Max.	Units
Reference Input Voltage	LX6431	V <sub>REF</sub>	$I_K = 10 \text{mA}, V_{KA} = V_{REF}, T_A = 25 ^{\circ}\text{C},$	2440	02.13	2550	m۷
	LX6431A	S I SPRING	$I_K = 10 \text{mA}, V_{KA} = V_{REF}, T_A = 25 ^{\circ}\text{C}$	2470	E CUR	2520	mV
	LX6431B	ON BR	$I_{K} = 10 \text{mA}, V_{KA} = V_{REF}, T_{A} = 25 ^{\circ} \text{C}$	2490	DAD 31	2510	mV
Reference Drift	LX6431	atole.	$I_K = 10 \text{mA}$ , $V_{KA} = V_{REF}$ , $0^{\circ}\text{C} \le T_A \le 70^{\circ}\text{C}$	HEER A	6863	15	mV
			$I_K = 10 \text{mA}, V_{KA} = V_{REF}, -40 \text{°C} \le T_A \le 85 \text{°C}$	IA-33	A vav 3	25	mV
	LX6431A		$I_K = 10$ mA, $V_{KA} = V_{REF}$ , $0^{\circ}$ C $\leq T_A \leq 70^{\circ}$ C	RUT IN	d THE	15	mV
		S HE STATE	$I_{K} = 10 \text{mA}, V_{KA} = V_{REF}, -40 ^{\circ}\text{C} \le T_{A} \le 85 ^{\circ}\text{C}$			25	mV
	LX6431B		$I_K = 10$ mA, $V_{KA} = V_{REF}$ , $0$ °C $\leq T_A \leq 70$ °C			15	mV
		PT THEORY	$I_{K} = 10 \text{mA}, V_{KA} = V_{REF}, -40 \text{°C} \le T_{A} \le 85 \text{°C}$	- 0	E.F.L.	20	m۷
Voltage Ratio, Reference to Cathode		FI VILLYARD	$I_K = 10 \text{mA}, V_{KA} = 2.5 \text{V to 36V}, T_A = 25 ^{\circ} \text{C}$		0.3	1	mV/V
(Note 3)		in The cons	$I_K = 10$ mA, $V_{KA} = 2.5$ V to 36V, $T_A = 0$ perating Range		0.3	1	mV/V
Reference Input Current	40	I <sub>REF</sub>	$V_{KA} = V_{REF}$ , $T_A = 25$ °C	4.75	0.1	0.5	μА
			$V_{KA} = V_{REF}, T_A = Operating Range$		0.1	0.5	μΑ
Minimum Operating Current		I <sub>MIN</sub>	$V_{KA} = V_{REF}$ to 36V, $T_A = 25^{\circ}$ C		0.4	0.6	mA
			$V_{KA} = V_{REF}$ to 36V, $T_A = Operating Range$		0.4	0.6	mA
Off-State Cathode Current	OU SOURCE TERM	I <sub>OFF</sub>	$V_{KA} = 36V, V_{REF} = 0V, T_A = 25^{\circ}C$	1 1	0.3	1	μА
Dynamic Impedance		Z <sub>KA</sub>	$V_{KA} = V_{REF} I_{K} = 0.6 \text{mA} \text{ to } 100 \text{mA}, f \le 1 \text{kHz}, T_{A} = 25 ^{\circ}\text{C}$		30	100	mΩ

Note 2. These parameters are guaranteed by design.

Note 3.  $\frac{\Delta V_{\text{BEF}}}{\Delta V_{\text{KA}}}$  Ratio of change in reference input voltage to the change in cathode voltage.



#### **GRAPH / CURVE INDEX**

#### **Characteristic Curves**

#### FIGURE #

- 1. REFERENCE VOLTAGE vs. FREE-AIR TEMPERATURE
- 2. REFERENCE CURRENT vs. FREE-AIR TEMPERATURE
- 3. CATHODE CURRENT vs. CATHODE VOLTAGE
- 4. OFF-STATE CATHODE CURRENT vs. FREE-AIR TEMPERATURE
- 5. RATIO OF DELTA REFERENCE VOLTAGE TO DELTA CATHODE VOLTAGE vs. FREE-AIR TEMPERATURE
- 6. EQUIVALENT INPUT NOISE VOLTAGE vs. FREQUENCY

#### FIGURE INDEX

#### **Application Information**

#### FIGURE #

- COMPARISON OF REFERENCE RESISTOR VALUES BETWEEN AN LX6431B AND A TL1431. Resistors used with the LX6431B are 5 times higher in value.
- COMPARISON OF REFERENCE RESISTOR VALUES BETWEEN AN LX6431B AND A TL1431. When used as 0.5%, 5V shunt regulators.

#### **Parameter Measurement Information**

#### FIGURE #

- 9. TEST CIRCUIT FOR  $V_{KA} = V_{REF}$
- 10. TEST CIRCUIT FOR  $V_{KA} > V_{REF}$
- 11. TEST CIRCUIT FOR I

#### Typical Characteristics

#### FIGURE #

- 12. EQUIVALENT INPUT NOISE VOLTAGE OVER A 10-SECOND PERIOD
- 13. SMALL-SIGNAL VOLTAGE AMPLIFICATION vs. FREQUENCY
- 14. REFERENCE IMPEDANCE vs. FREQUENCY
- 15. PULSE RESPONSE
- 16. DIFFERENTIAL VOLTAGE AMPLIFICATION vs. FREQUENCY



#### PRECISION PROGRAMMABLE REFERENCES

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#### CHARACTERISTIC CURVES

FIGURE 1. — REFERENCE VOLTAGE

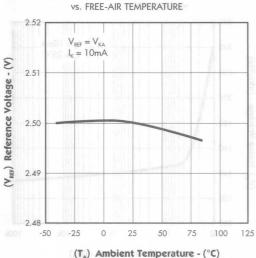


FIGURE 2. — REFERENCE CURRENT

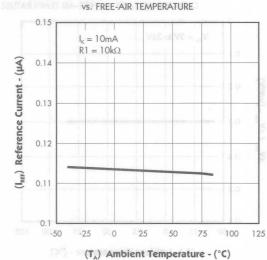


FIGURE 3. — CATHODE CURRENT vs. CATHODE VOLTAGE

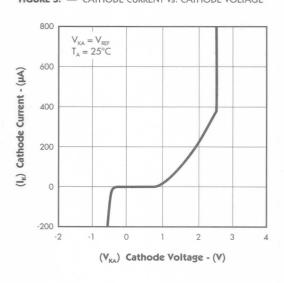
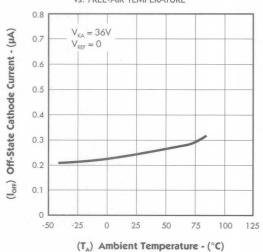


FIGURE 4. — OFF-STATE CATHODE CURRENT vs. FREE-AIR TEMPERATURE





#### PRECISION PROGRAMMABLE REFERENCES

PRODUCTION DATA SHEET

#### CHARACTERISTIC CURVES

FIGURE 5. — RATIO OF DELTA REFERENCE VOLTAGE TO DELTA CATHODE VOLTAGE vs. FREE-AIR TEMPERATURE

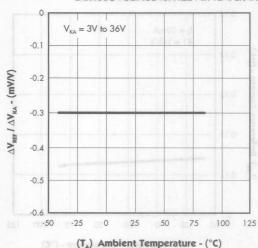
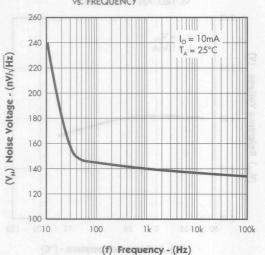
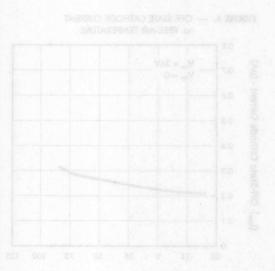


FIGURE 6. — EQUIVALENT INPUT NOISE VOLTAGE vs. FREQUENCY





#### PRECISION PROGRAMMABLE REFERENCES

#### PRODUCTION DATA SHEET

#### APPLICATION INFORMATION

#### **Application Hints**

The reference input current of the LX6431 series voltage references is much lower than other similar precision parts. This helps to design programmable voltage references that can use much higher value programming resistors while maintaining the same accuracy as the other precision parts. Figure 7 below shows a 5V, 1% shunt regulator using the LX6431B and a shunt regulator using the TL1431 (Also available from Linfinity). Figure 8 shows 0.5% shunt regulators. Noteworthy are the values of the reference resistors used in the two circuits. With the LX6431B it is possible to use 25k resistors for setting the output voltage with 1% precision as opposed to 5k programming resistors when the same precision needs to be achieved with a TL1431.

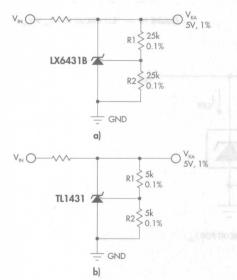


FIGURE 7 — Comparison of reference resistor values between an LX6431B and an TL1431, resistors used with the LX6431B are 5 times higher in value.

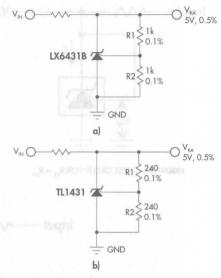


FIGURE 8 — Comparison of reference resistor values between an LX6431B and a TL1431, when used as 0.5%, 5V shunt regulators.

The output voltage of the reference can be programmed by using the formula below:

$$V_{KA} \cong 2.5 * \left(1 + \frac{R1}{R2}\right)$$

If more accuracy is required then the effects of the input bias current  $(I_{\text{REP}})$  must be taken into account. The formula below accounts for the error this current produces.

$$V_{KA} = 2.5 * \left(1 + \frac{R1}{R2}\right) + I_{REF} * R1$$

Smaller values of programming resistors tend to minimize bias current errors. In this respect the low input current characteristics of the LX6431B helps to reduce the power dissipation on the programming resistors by a factor of five compared to other references like the TL1431 and TL431.

The LX6431 series of voltage references have an enhanced circuit design that can tolerate any value of cathode to anode capacitance.



#### PARAMETER MEASUREMENT INFORMATION

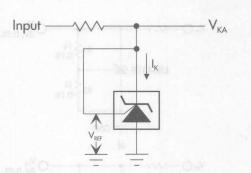


FIGURE 9 — TEST CIRCUIT FOR  $V_{KA} = V_{REF}$ 

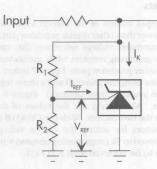
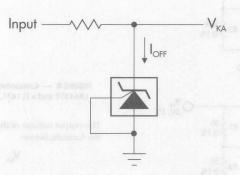


FIGURE 10 - TEST CIRCUIT FOR V - V PFF



and Jugate and the abadia and manufacturers of FIGURE 11 — TEST CIRCUIT FOR I



ferences like the TDF31 and TDF31.
The DX643 series of voltage references have an only creat design that can reference any volum of cathode to a

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#### TYPICAL CHARACTERISTICS

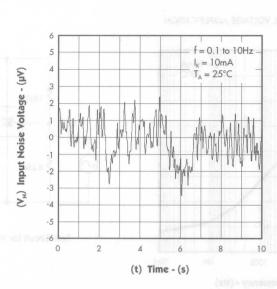
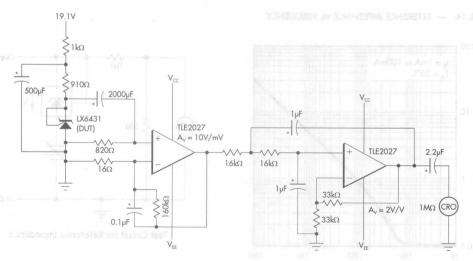


FIGURE 12. — EQUIVALENT INPUT NOISE VOLTAGE OVER A 10-SECOND PERIOD



Test Circuit for 0.1Hz to 10Hz Equivalent Input Noise Voltage

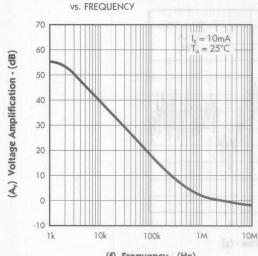


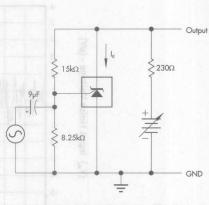
#### PRECISION PROGRAMMABLE REFERENCES

PRODUCTION DATA SHEET

#### TYPICAL CHARACTERISTICS

FIGURE 13. — SMALL-SIGNAL VOLTAGE AMPLIFICATION

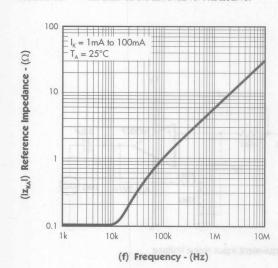


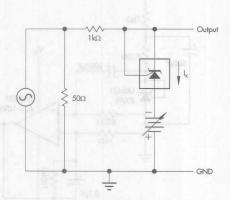


Test Circuit for Voltage Amplification

(f) Frequency - (Hz)

#### FIGURE 14. — REFERENCE IMPEDANCE vs. FREQUENCY





Test Circuit for Reference Impedance

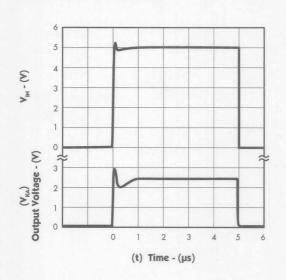


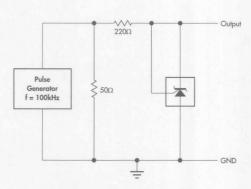
#### PRECISION PROGRAMMABLE REFERENCES

#### PRODUCTION DATA SHEET

#### TYPICAL CHARACTERISTICS

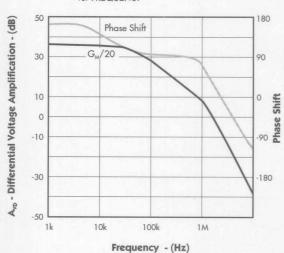
FIGURE 15. — PULSE RESPONSE

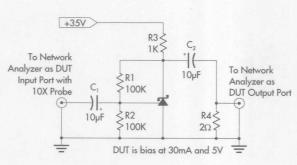




Test Circuit for Pulse Response

FIGURE 16. — DIFFERENTIAL VOLTAGE AMPLIFICATION vs. FREQUENCY

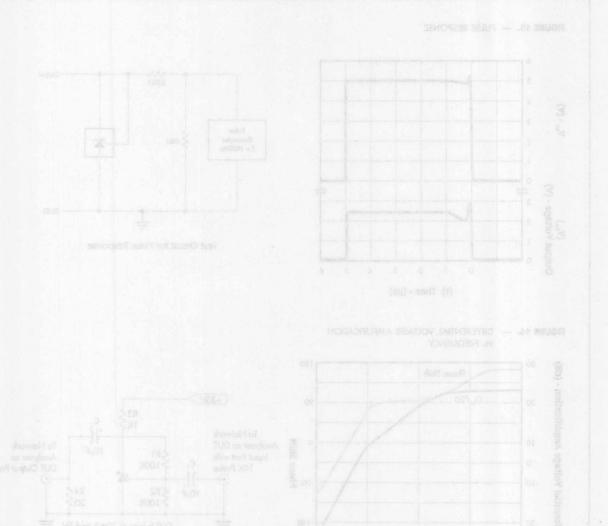




Test Setup for Measuring A<sub>VD</sub> vs. Frequency

# Notes

PRODUCTION DATA SELET









#### THE INFINITE POWER OF INNOVATION

#### VOLTAGE REFERENCES

#### NOT RECOMMENDED FOR NEW DESIGNS / LIFETIME BUY

#### DESCRIPTION

The SG103 is a two-terminal integrated circuit designed for analog and/or digital applications requiring precision voltage reference. The SG103 is an improved version of the National LM103 voltage reference. The design uses the band-gap voltage of the silicon as an internal reference for a tightly regulated output voltage. The advantages of this method over single junction zener diodes are: lower turn

on drift, better temperature coefficient, sharper breakdown characteristics (line regulation) and lower dynamic impedance (load regulation). The I.C. is available in thirteen different voltages ranging from 1.8V to 5.1V (See Table below). The SG103 is packaged in a hermetically sealed, modified TO-46 header and is specified for operation over the full military ambient temperature range of -55°C to +125°C.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### KEY FEATURES

- STANDARD VOLTAGE TOLERANCE ±10%
- PRECISION BAND GAP DESIGN
- EXCEPTIONALLY SHARP BREAKDOWN
- LOW DYNAMIC IMPEDANCE FROM 10µA TO 10mA (IMPROVED OVER LM103)
- IMPROVED TEMPERATURE COEFFICIENT
- LOW CAPACITANCE
- PERFORMANCE GUARANTEED OVER FULL MILITARY TEMPERATURE RANGE

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

#### AVAILABLE OPTIONS PER PART #

Part #	Reference Voltage
SG103-1.8	1.8V
SG103-2.4	2.4V
SG103-2.7	2.7V
SG103-3.3	3.3V
SG103-4.7	4.7V
SG103-5.1	5.1V

#### PACKAGE PIN OUTS



# PACKAGE ORDER INFORMATION

T <sub>A</sub> (°C)	<b>Z</b> TO-46 Metal Can 2-pin			
-55 to 125	SG103-x.xZ			
	SG103-1.8Z/DESC			
DESC	SG103-2.7Z/DESC			
	SG103-4.7Z/DESC			

"x.x" refers to Reference Voltage, see table above.

#### FOR FURTHER INFORMATION CALL (714) 898-8121

# Notes

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- L STANDARD VOLTAGE TO LEICHTOF 10%
  - ME ENECUTION SAND GAP DESIGN
- BINCEPHONALLY SHARP BREAKDOWN
- ILOW DWIAMIC IMPEDANCE FROM 10(1)
  TO 10mA (UNRICHED CNER) M103)
- MININOVED TEMPERATURE CONTROLLINE
  - S LOW CAPACITANCE
- III PERFORMANCE GUARANTEED OVER RAIL
  MILITARY TEMPERATURE RANGE

#### HIGH PENJARINTY FEATURES

- の AVAILABLE TO MIL-STD-803B AND
- INTENSITY LEVEL "S" PROCESSING AVAILABLE

on dust, betwee semperature coefficients, stranger breakflown characteristics (time regulation) and lower dynamic impedance flood regulation). The E.C. is revelable in distrect different voluges empire from 1.8V to 5.1V (See Table) believed. The SG103 is parkaged in a beancerically scalest, modified TO-40 beancerically scalest, modified TO-40 over the full-military lamblem temperature.

The SCI03 is a two-terminal integrated circuit designed for analog and/or digital applications requiring precision voltage reference. The SCI05 is an improved version of the National LAH03 voltage reference. The design uses the band-gap voltage of the siticon as in internal reference for a tightly regulated output voltage. The advantages of his method over STale advantages of his method over STale advantages of his method over STale and the state of the siticon tights of the sitic of the sitic of the situation of the situation

COMPLETE SPECIFICATIONS AVAILABLE FROM "LAN" FAX SYSTEM
(See Page 4-1) AND 1990/91 SHICON GENTERL DATABOOK

#### AVAILABLE OFTIONS PER PART #

	50103-1.8
	56103-3.3



TO-16 Metal Can	







THE INFINITE POWER OF INNOVATION

#### HIGH-VOLTAGE OPERATIONAL AMPLIFIER

NOT RECOMMENDED FOR NEW DESIGNS

#### DESCRIPTION

The SG143 is a general-purpose highvoltage operational amplifier featuring operation to ±40V and overvoltage protection up to ±40V. Increased slew rate, together with higher commonmode and supply rejection, insure improved performance at high supply voltages. Operating characteristics are independent of supply voltage and temperature. These devices are intended for use in high voltage applications where common-mode input ranges, high output voltage swings, and low input currents are required. Also, they are internally compensated and are pin compatible with industry standard operational amplifiers.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### KEY FEATURES

- ±4.0V TO ±40V SUPPLY VOLTAGE RANGE
- ±37V OUTPUT VOLTAGE SWING
- ±24V COMMON-MODE VOLTAGES
- OVERVOLTAGE PROTECTION
- OUTPUT SHORT CIRCUIT PROTECTION

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

# OFFSET ADJUST 1 8 N.C. INVERTING INPUT 2 7 V+ NON-INVERTING INPUT 3 6 OUTPUT V- 4 5 OFFSET ADJUST Y PACKAGE (Top View) N.C. OFFSET ADJUST 1 8 N.C. N.C. OFFSET ADJUST 1 8 N.C.

OFFSET ADJUST

T PACKAGE (Top View)

NON-INVERTING INPUT

PACKAGE PIN OUTS

PACKAGE ORDER INFORMATION			
T <sub>A</sub> (°C)	Y Ceramic DIP 8-pin	T TO-99 Metal Can 8-pin	
-55 to 125	SG143Y	SG143T	
MIL-STD-883	SG143Y/883B	SG143T/883B	
DESC	SG143Y/DESC	SG143T/DESC	

# Notes





# SG1503/SG2503/SG3503

#### PRECISION 2.5 VOLT REFERENCE

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

This monolithic integrated circuit is a fully self-contained precision voltage reference generator, internally trimmed for ±1% accuracy. Requiring less than 2mA in quiescent current, this device can deliver in excess of 10mA with total load- and line-induced tolerances of less than 0.5%. In addition to voltage accuracy, internal trimming achieves a temperature coefficient of output voltage of typically 10 ppm/°C.

As a result, these references are excellent choices for application to critical instrumentation and D-to-A converter systems.

The SG1503 is specified for operation over the full military ambient temperature range of -55°C to 125°C, while the SG2503 is designed for -25°C to 85°C and the SG3503 for commercial applications of 0°C to 70°C.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### KEY FEATURES

- OUTPUT VOLTAGE TRIMMED TO ±1%
- INPUT VOLTAGE RANGE OF 4.5 TO 40V
- TEMPERATURE COEFFICIENT OF 10ppm/°C
- QUIESCENT CURRENT TYPICALLY 1.5mA
- OUTPUT CURRENT IN EXCESS OF 10mA
- INTERCHANGEABLE WITH MC1503 AND AD580

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

#### PACKAGE PIN OUTS



M & Y PACKAGE (Top View)



OM PACKAGE (Top View)



T PACKAGE (Top View)

PACKAGE ORDER INFORMATION						
T <sub>A</sub> (°C)	M Plastic DIP 8-pin	Y Ceramic DIP 8-pin	DM Plastic SOIC 8-pin	T TO-39 Metal Can 3-pin		
0 to 70	. SG3503M	SG3503Y	SG3503DM	SG3503T		
-25 to 85	SG2503M	SG2503Y	_	SG2503T		
-55 to 125	_	SG1503Y	_	SG1503T		
MIL-STD-883	-	SG1503Y/883B	_	SG1503T/883B		
DESC	_	SG1503Y/DESC		SG1503T/DESC		

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3503DMT)

# Notes

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BI LIMBINIO LEVEL "S" PROCESSING AVAILABLE As a result, these retinences not excellent choices for application to crutest to strength and D-to-A converter systems.

Otherm systems of the Sci SOS as specified for operation over the full military scottent temperature range of -57% to 125%, while the Sci SOS is designed for 257% to 189% and the SCI SOS for commercial masks at the SCI SOS OF Commercial masks at the SCI SOS OF COMMERCIAL SCI OF SCI SOS OF COMMERCIAL SCI OF SC

This monolithic integrated circuit is a fully self-contained precision voltage fully self-contained precision voltage for ±1% acctuacy. Requiring less than 2mA in quiescent current this device can deliver in excess of 10mA with total loads and line-induced tolerances of less than 0.5% in addition to voltage accuracy, internal trimming achieves a temperature coefficient of contact voltage of voltage for the form of the contact of the cont

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM
(See Page 4-1) AND 1990/91 SHLEON GENERAL DATABOOK

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TEACHLAGE (Top View)



# SG1536/SG1436

#### HIGH-VOLTAGE OPERATIONAL AMPLIFIER

THE INFINITE POWER OF INNOVATION

NOT RECOMMENDED FOR NEW DESIGNS

#### DESCRIPTION

The SG1536 series of monolithic amplifiers is designed specifically for use in high voltage applications up to ±40V and where high common-mode input ranges, high output voltage

swings, and low input currents are required. These devices are internally compensated and are pin compatible with industry standard operational amplifiers.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### KEY FEATURES

- HIGH SUPPLY VOLTAGE CAPABILITY
- HIGH OUTPUT VOLTAGE SWING
- HIGH COMMON-MODE VOLTAGE RANGE
- INTERNAL FREQUENCY COMPENSATION
- INPUT CURRENT 35nA MAXIMUM OVER TEMPERATURE

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- LINFINITY LEVEL "S" PROCESSING AVAILABLE

# OFFSET ADJUST INVERTING INPUT WAY PACKAGE (Top View) N.C. OFFSET ADJUST OFFSET ADJUST N.C. OFFSET ADJUST OFFSET ADJUST OFFSET ADJUST OFFSET ADJUST OFFSET ADJUST V T PACKAGE

PACKAGE ORDER INFORMATION					
T <sub>A</sub> (°C)	M Plastic DIP 8-pin	Y Ceramic DIP 8-pin	T TO-99 Metal Can 8-pin		
0 to 70	SG1436M	SG1436Y	SG1436T		
-55 to 125	<del>-</del>	SG1536Y	SG1536T		
MIL-STD-883	_	SG1536Y/883B	SG1536T/883B		
DESC	_	SG1536Y/DESC	SG1536T/DESC		

(Top View)

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to ings, and low ingsit commission of required. Hence devices are meanable companied and size pit trompublish

The SG1536 series of moralithic applifiers is designed aposifically for a designed aposifically for the high voltage applifications up to 250V and where high common-assist most series voltage.

CONFLETE SPECIFICATIONS AVAILABLE FILIA "TJM" P.V. System (See Page 4-1) also 1990/91 Silvicon General Darabook

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# TL431/TL431A/TL431B

#### PRECISION PROGRAMMABLE REFERENCES

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

The TL431/TL431A/TL431B series precision adjustable three terminal shunt voltage regulators are pin-to-pin compatible with the industry standard TL431. The output voltage of this reference is programmable by using two external resistors from 2.5V to 36V.

These devices offer low output

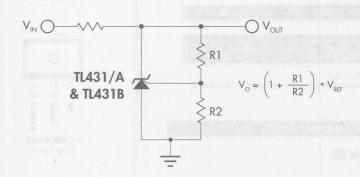
impedance for improved load regulation. The typical output impedance of these devices is  $200m\Omega$ . These devices find application in the feedback path of switching power supplies, OVP crowbar circuits, reference for A/D, D/A, and as zener diodes with improved turn-on characteristics.

#### KEY FEATURES

- INITIAL VOLTAGE REFERENCE ACCURACY OF 0.4% (TL431B)
- ☐ SINK CURRENT CAPABILITY 1mA to 100mA
- $\hfill\Box$  Typical output dynamic impedance less than 200m  $\!\Omega_{\rm F}$  Typical output impedance of the TL431B less than 100m  $\!\Omega$
- ADJUSTABLE OUTPUT VOLTAGE FROM 2.5V TO 36V
- AVAILABLE IN SURFACE-MOUNT PACKAGES
- LOW OUTPUT NOISE
- TYPICAL EQUIVALENT FULL RANGE TEMPERATURE COEFFICIENT OF 30ppm/°C
- ☐ DIRECT PIN-TO-PIN REPLACEMENT FOR INDUSTRY STANDARD TL431 AND TL1431

#### PRODUCT HIGHLIGHT

PRECISION PROGRAMMABLE REFERENCES



PACKAGE ORDER INFORMATION						
T <sub>A</sub> (°C)	Initial Tolerance	DM Plastic SOIC 8-pin	LP Plastic TO-92 3-pin	PK Plastic SOT-89 3-pin		
0 to 70	2%	TL431CDM	TL431CLP	TL431CPK		
	1%	TL431ACDM	TL431ACLP	TL431ACPK		
	0.4%	TL431BCDM	TL431BCLP	TL431BCPK		
	2%	TL431IDM	TL431ILP	TL431IPK		
-40 to 85	1%	TL431AIDM	TL431AILP	TL431AIPK		
	0.4%	TL431BIDM	TL431BILP	TL431BIPK		

Note: All surface-mount packages are available in Tape & Reel.

Append the letter "T" to part number. (i.e. TL431CDMT)

TO-92 (LP) package also available in ammo-pack.

# TL431/TL431A/TL431B

#### PRECISION PROGRAMMABLE REFERENCES

#### PRODUCTION DATA SHEET

#### ABSOLUTE MAXIMUM RATINGS (Note 1)

Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal. Pin numbers refer to DIL packages only.

Note 2. Voltage values are with respect to the anode terminal unless otherwise noted.

#### THERMAL DATA

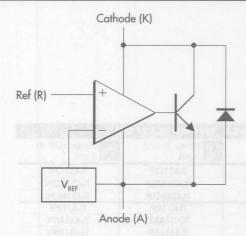
#### DM PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ,	165°C/W
IP PACKAGE:	163 C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ.	156°C/W
PK PACKAGE:	-aVO
THERMAL RESISTANCE-JUNCTION TO TAB, $\theta_{_{ m JT}}$	35°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{J_A}}$	71°C/W

Junction Temperature Calculation:  $T_1 = T_A + (P_D \times \theta_{1A})$ .

The  $\theta_{j_A}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow

#### BLOCK DIAGRAM



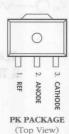
#### PACKAGE PIN OUTS



DM PACKAGE (Top View)



LP PACKAGE (Top View)



40 to 85

# TL431/TL431A/TL431B

#### PRECISION PROGRAMMABLE REFERENCES

#### PRODUCTION DATA SHEET

#### ELECTRICAL CHARACTERISTICS (Note 3)

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for TL431C/TL431AC/TL431BC with  $0^{\circ}\text{C} \leq T_{A} \leq 70^{\circ}\text{C}$ , TL431L/TL431AI/TL431BI with  $-40^{\circ}\text{C} \leq T_{A} \leq 85^{\circ}\text{C}$ .)

Parameter		Symbol	Test Conditions		TL431/431A/431B Min. Typ. Max.		
	TI 101	14		-	-		
Reference Input Voltage	TL431	V <sub>REF</sub>	$I_K = 10$ mA, $V_{KA} = V_{REF}$ , $T_A = 25$ °C	-	2495		mV
	TL431A	H TIUUMED	$I_{K} = 10 \text{mA}, V_{KA} = V_{REF}, T_{A} = 25 ^{\circ}\text{C}$		2495		mV
	TL431B		$I_K = 10\text{mA}$ , $V_{KA} = V_{REF}$ , $T_A = 25^{\circ}\text{C}$	2490	2500	2510	mV
Reference Drift	TL431C		$I_{K} = 10 \text{mA}$ , $V_{KA} = V_{REF}$	ROOM	4	17	mV
	TL431I		$I_K = 10 \text{mA}, V_{KA} = V_{REF}$	I REGILA	5	30	m۷
	TL431AC	$\Delta V_{REF}$	$I_K = 10 \text{mA}, V_{KA} = V_{REF}$	A-139	4	170	m٧
	TL431AI	ΔV <sub>KA</sub>	$I_K = 10 \text{mA}, V_{KA} = V_{REF}$	L T1 100	5	30	mV
	TL431BC	L-SKIMAL	$I_K = 10 \text{mA}, V_{KA} = V_{RFF}$		4	15	m۷
	TL431BI	0.4035143	$I_K = 10 \text{mA}, V_{KA} = V_{RFF}$		5	20	m٧
Voltage Ratio, Ref to Cathode (Note 4)	TL431, TL431A	andoon :	$J_K = 10 \text{mA}, V_{KA} = 2.5 \text{V to } 36 \text{V}$		-1.4	-2.7	mV/\
	TL431B	101000	$I_K = 10 \text{mA}, V_{KA} = 2.5 \text{V to } 36 \text{V}$		-1.1	-2	mV/\
Reference Input Current	TL431,TL431A	IREF	$V_{KA} = V_{REF} T_A = 25^{\circ}C$	0.3	2	4	μА
	TI 424D		$V_{KA} = V_{RFF} T_A = 25^{\circ}C$		1.5	1.9	μА
	TL431B	L431B	$V_{KA} = V_{RFF} T_A = Operating Range$	506	Mario I	2.3	μА
Minimum Operating Current		I <sub>MIN</sub>	$V_{KA} = V_{PFF}$ to 36V		0.4	1	mA
Off-State Cathode Current	TL431	I <sub>OFF</sub>	V <sub>KA</sub> = V <sub>RFF</sub> to 36V, T <sub>A</sub> = 25°C		0.1	1	μА
	TL431A	LUES ER IR	V <sub>KA</sub> = V <sub>RFF</sub> to 36V, T <sub>A</sub> = 25°C		0.1	1	μА
	COMBASATOR V	6/99t/8-31	V <sub>KA</sub> = V <sub>REF</sub> to 36V, T <sub>A</sub> = Operating Range			2	μА
	TL431B	CHOM	V <sub>KA</sub> = 36V, V <sub>ppp</sub> = 0V, T <sub>A</sub> = 25°C		0.18	0.5	μА
Dynamic Impedance	TL431	1ZKA1	$V_{KA} = V_{REF}$ , $I_{K} = 1$ mA to 100mA, $f \le 1$ kHz, $T_{A} = 25$ °C		0.2	0.5	Ω
	TL431B	DAD RASH	$V_{VA} = V_{BEF}$ , $I_{V} = 1$ mA to 100mA, $f \le 1$ kHz, $T_{A} = 25$ °C		0.1	0.2	Ω

Note 3. These parameters are guaranteed by design.

 $\label{eq:Note 4.} \begin{array}{l} \frac{\Delta V_{_{REF}}}{\Delta V_{_{KA}}} & \text{Ratio of change in reference input voltage} \\ \text{to the change in cathode voltage}. \end{array}$ 



## PRECISION PROGRAMMABLE REFERENCES

PRODUCTION DATA SHEET

#### GRAPH / CURVE INDEX

#### **Characteristic Curves**

#### FIGURE #

- 1. REFERENCE INPUT VOLTAGE vs. FREE-AIR TEMPERATURE
- 2. REFERENCE INPUT CURRENT vs. FREE-AIR TEMPERATURE
- 3. CATHODE CURRENT vs. CATHODE VOLTAGE
- 4. CATHODE CURRENT vs. CATHODE VOLTAGE
- 5. OFF-STATE CATHODE CURRENT vs. FREE-AIR TEMPERATURE
- 6. RATIO OF DELTA REFERENCE VOLTAGE TO DELTA CATHODE VOLTAGE vs. FREE-AIR TEMPERATURE
- 7. EQUIVALENT INPUT NOISE VOLTAGE vs. FREQUENCY

#### FIGURE INDEX

#### **Parameter Measurement Information**

#### FIGURE #

- 8. TEST CIRCUIT FOR  $V_{KA} = V_{REF}$
- 9. TEST CIRCUIT FOR  $V_{KA} > V_{REF}$
- 10. TEST CIRCUIT FOR I

#### Typical Characteristics

#### FIGURE :

- 11. EQUIVALENT INPUT NOISE VOLTAGE OVER A 10-SECOND PERIOD
- 12. SMALL-SIGNAL VOLTAGE AMPLIFICATION vs. FREQUENCY
- 13. REFERENCE IMPEDANCE vs. FREQUENCY
- 14. PULSE RESPONSE
- 15. STABILITY BOUNDARY CONDITIONS

## Application Information

#### FIGURE #

- 16. SHUNT REGULATOR
- 17. SINGLE-SUPPLY COMPARATOR WITH TEMPERATURE-COMPENSATED THRESHOLD
- 18. HIGH CURRENT SHUNT REGULATOR
- 19. CROWBAR CIRCUIT
- 20. VOLTAGE MONITOR
- 21. PRECISION CONSTANT-CURRENT SINK

## PRECISION PROGRAMMABLE REFERENCES

PRODUCTION DATA SHEET

## CHARACTERISTIC CURVES

FIGURE 1. — REFERENCE VOLTAGE

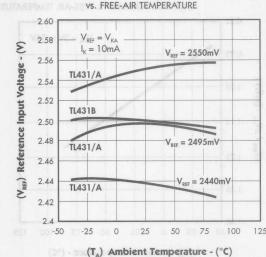


FIGURE 2. — REFERENCE CURRENT Vs. FREE-AIR TEMPERATURE

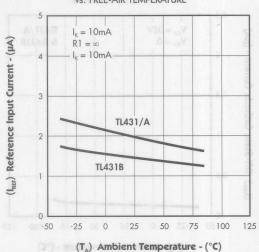


FIGURE 3. — CATHODE CURRENT vs. CATHODE VOLTAGE

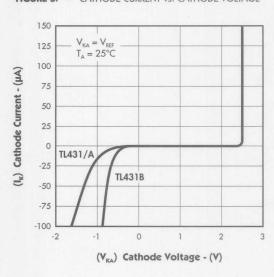
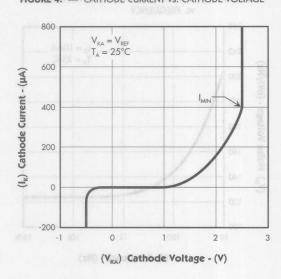


FIGURE 4. — CATHODE CURRENT VS. CATHODE VOLTAGE



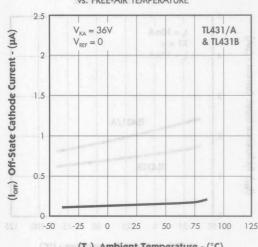


## Precision Programmable References

PRODUCTION DATA SHEET

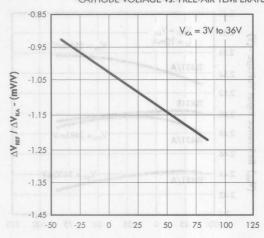
#### CHARACTERISTIC CURVES

FIGURE 5. — OFF-STATE CATHODE CURRENT vs. FREE-AIR TEMPERATURE



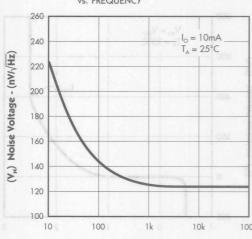
(T<sub>A</sub>) Ambient Temperature - (°C)

FIGURE 6. — RATIO OF DELTA REFERENCE VOLTAGE TO DELTA CATHODE VOLTAGE vs. FREE-AIR TEMPERATURE

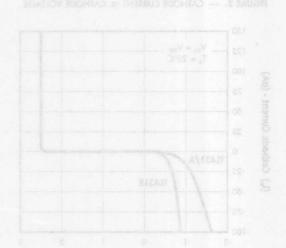


(T<sub>A</sub>) Ambient Temperature - (°C)

FIGURE 7. — EQUIVALENT INPUT NOISE VOLTAGE vs. FREQUENCY



(f) Frequency - (Hz)





## PRECISION PROGRAMMABLE REFERENCES

PRODUCTION DATA SHEET

## PARAMETER MEASUREMENT INFORMATION

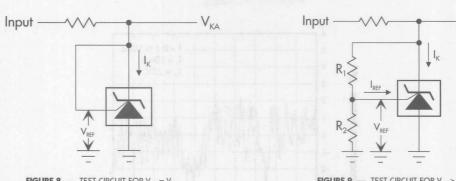


FIGURE 8 - TEST CIRCUIT FOR VKA = VREF

FIGURE 9 — TEST CIRCUIT FOR VKA > VREF

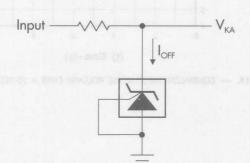


FIGURE 10 — TEST CIRCUIT FOR I

## PRECISION PROGRAMMABLE REFERENCES

PRODUCTION DATA SHEET

#### TYPICAL CHARACTERISTICS

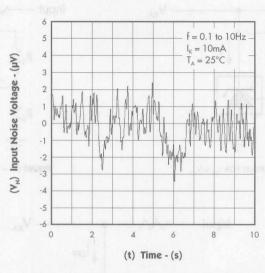
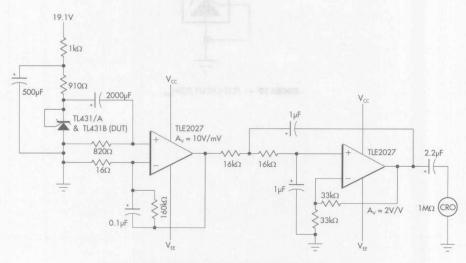


FIGURE 11. — EQUIVALENT INPUT NOISE VOLTAGE OVER A 10-SECOND PERIOD



Test Circuit for 0.1Hz to 10Hz Equivalent Input Noise Voltage



## PRECISION PROGRAMMABLE REFERENCES

PRODUCTION DATA SHEET

#### TYPICAL CHARACTERISTICS

FIGURE 12. — SMALL-SIGNAL VOLTAGE AMPLIFICATION vs. FREQUENCY

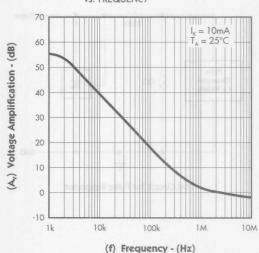
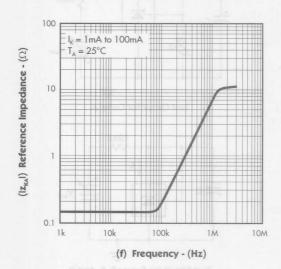
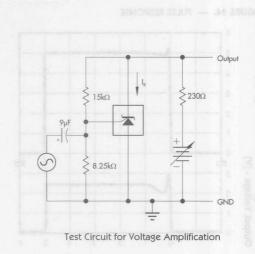
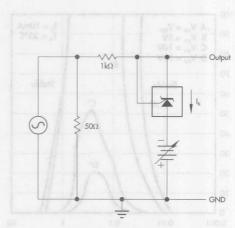


FIGURE 13. — REFERENCE IMPEDANCE vs. FREQUENCY







Test Circuit for Reference Impedance

## PRECISION PROGRAMMABLE REFERENCES

## PRODUCTION DATA SHEET

#### TYPICAL CHARACTERISTICS

FIGURE 14. — PULSE RESPONSE

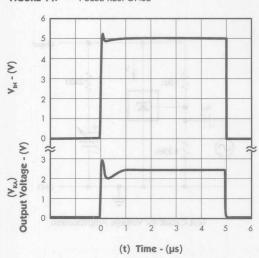
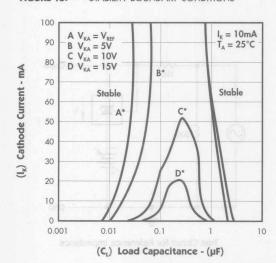
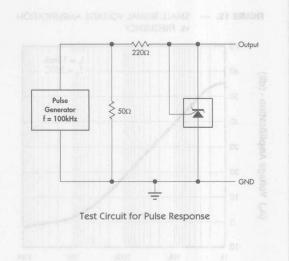
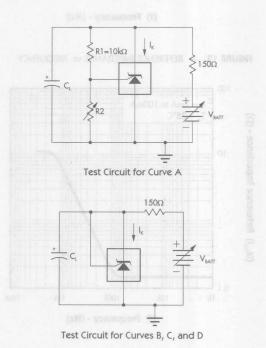


FIGURE 15. — STABILITY BOUNDARY CONDITIONS



\* The areas under the curves represent conditions that may cause the device to oscillate. For curves B, C, and D, R2 and V+ were adjusted to establish the initial  $V_{\zeta_A}$  and  $I_{\chi}$  conditions with  $C_L=0$ .  $V_{BATT}$  and  $C_L$  were then adjusted to determine the ranges of stability.



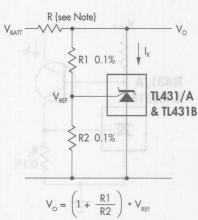




## PRECISION PROGRAMMABLE REFERENCES

PRODUCTION DATA SHEET

#### APPLICATION INFORMATION



Note: R should provide  $\geq$  1 mA cathode current to the TL431/A & TL1431 at minimum  $V_{BAT}$ .

FIGURE 16 — SHUNT REGULATOR

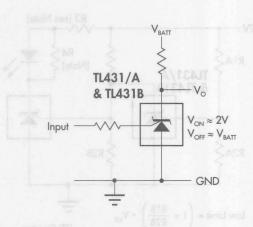


FIGURE 17 — SINGLE-SUPPLY COMPARATOR WITH TEMPERATURE-COMPENSATED THRESHOLD

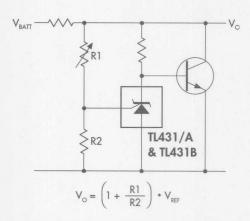
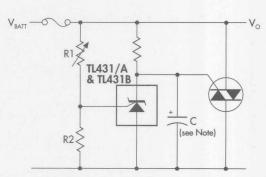


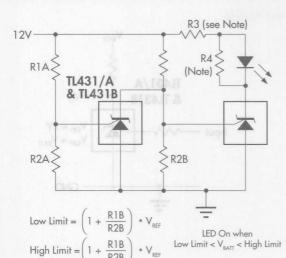
FIGURE 18 — HIGH CURRENT SHUNT REGULATOR



Note: Refer to the stability boundary conditions in Figure 15 to determine allowable values for C.

FIGURE 19 — CROWBAR CIRCUIT

#### APPLICATION INFORMATION



Note: R3 and R4 are selected to provide the desired LED intensity and ≥ 1mA cathode current to the TL431/A & TL431B at the available V+.

FIGURE 20 — VOLTAGE MONITOR

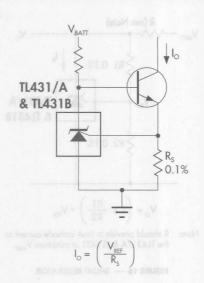
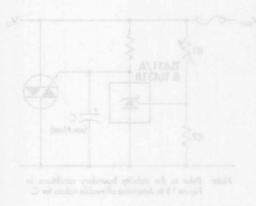
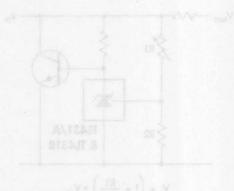


FIGURE 21 — PRECISION CONTANT-CURRENT SINK





Introduction

Quality

**Working With Linfinity** 

**Linfinity Information Network** 

Part Number Selection / Info

**Power Supply Circuits** 

**Data Communication Circuits** 

**Signal Conditioning Circuits** 

**Motion Control Circuits** 

**Other Linear Circuits** 

**Military Products** 

**Discontinued Products** 

**Package Information** 

Representatives / Distributors

9



Notes



# **Section Index**

## MOTION CONTROL CIRCUITS

*LX3187 *LX3191B	Servo Actuated Drive Subsystem Hall-less Spindle Motor Driver	
Power Drivers	自	
SG1635/3635 SG3645	2A Half-Bridge DriverQuad 2.5A Power Driver	
PWM Controllers		
SG1731/2731/3731	DC Motor Pulse Width Modulator	9-35
Power Operational Ampl	lifiers	
SG2273/3273 SG3272	Power Operational Amplifier  Dual-Power Amplifier	

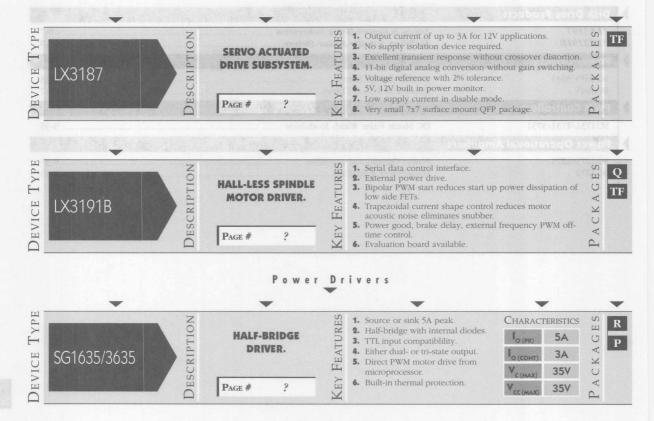
**Bold =** New Product, \*Bold Italic = Preliminary

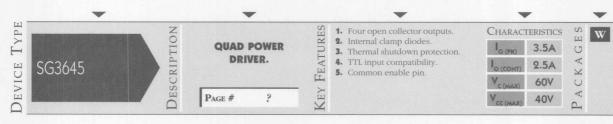


# Selection Guide

## MOTION CONTROL CIRCUITS

Disk Drive Products





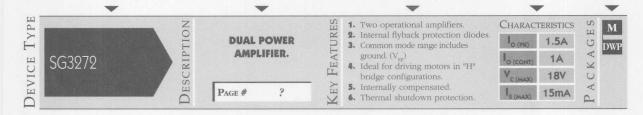
# **Selection Guide**

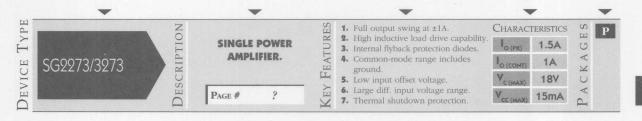
## MOTION CONTROL CIRCUITS

PWM Controllers

TYPE CHARACTERISTICS DESCRIPTION 1. Dual uncommitted totem pole outputs. 400mA DC MOTOR PULSE-WIDTH 2. Maximum frequency to 350KHz. MODULATOR. 200mA 3. Adjustable deadband operation. DEVICE SG1731/2731/3731 4. High slew rate op-amp. Y<sub>C (MAX)</sub> 5. Digital SHUTDOWN input. (50V) A ±25V ? PAGE # V<sub>CC (MAX)</sub> (36V)

## Power Operational Amplifiers





# Notes









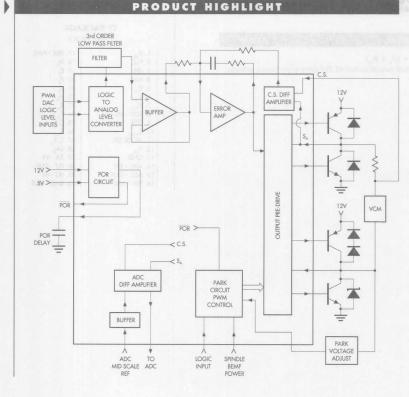
THE INFINITE POWER OF INNOVATION

PRELIMINARY DATA SHEET

#### DESCRIPTION

The LX3187 is a transconductor power driver for the voice coil actuator in high-performance disk drive applications. It provides the additional functions of precision reference voltage, 11-bit digital to analog conversion, power monitor / power-on reset generation, independent current sense

amplifier, uncommitted buffer amplifier, and velocity limiting power off park circuit. The only active components external to the 7 x 7 mm QFP package are 4 low-cost, surface-mount bipolar transistors and silicon recirculation diodes suitable for the desired load current of up to 3A.



#### KEY FEATURES

- OUTPUT CURRENTS OF UP TO 3A FOR 12V APPLICATIONS
- NO SUPPLY ISOLATION DÉVICE REQUIRED, NEAR RAIL-TO-RAIL OUTPUT VOLTAGE
- EXCELLENT TRANSIENT RESPONSE WITHOUT CROSSOVER DISTORTION
- 11-BIT DIGITAL TO ANALOG CONVERSION WITHOUT GAIN SWITCHING
- VOLTAGE REFERENCE WITH 2% TOLERANCE
- 5V, 12V BUILT-IN POWER MONITOR /
  POWER-ON RESET GENERATION
- ADDITIONAL CURRENT SENSE AMPLIFIER WITH INDEPENDENT OUTPUT VOLTAGE REFERENCE AND BUFFERED INPUT
- SWITCHING MODE PARK CIRCUIT. THAT
  OPERATES TO LESS THAN 2 V/BEMF AND
  PROVIDES ADJUSTABLE VELOCITY LIMITING
- LOW SUPPLY CURRENT IN DISABLE MODE
- VERY SMALL 7 X 7 SURFACE-MOUNT QFP PACKAGE
- UNCOMMITTED BUFFER AMPLIFIER TO BE CONFIGURED AS 3RD ORDER LOW PASS FILTER

#### APPLICATIONS

- HIGH-CAPACITY, HIGH-PERFORMANCE VOICE COIL SERVO SYSTEMS
- EVALUATION BOARD AVAILABLE

## PACKAGE ORDER INFO

T<sub>A</sub> (°C) TF 32-Pin TQFP

0 to 70 LX3187CTF

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number.

(i.e. LX3187CTFT)

FOR FURTHER INFORMATION CALL (714) 898-8121

## LX3187

## SERVO ACTUATOR DRIVE SUBSYSTEM

## 1338 SATA O YRAN PRELIMINARY DATA SHEET

## ABSOLUTE MAXIMUM RATINGS (Note 1) Supply Voltage ... Operating Junction Temperature Plastic (TF Package) ..... Storage Temperature Range ......-65°C to 150°C Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect

## THERMAL DATA

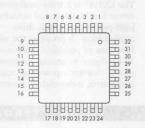
to Ground. Currents are positive into, negative out of the specified terminal.

#### TF PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT,  $\theta_{ij}$ 

Junction Temperature Calculation:  $T_j = T_A + (P_D \times \theta_{JA})$ . The  $\theta_{JA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow

## **PACKAGE PIN OUTS**



#### TF PACKAGE (Top View)

	Pr Section
1. V <sub>REF</sub>	17. PRK - PWR
2. N.C.	18. N <sub>R</sub>
3. LSB	19. E <sub>s</sub>
4. MSB	20. Pa
5. V <sub>cc</sub>	21. S <sub>B</sub>
6. V <sub>TH1</sub>	22. N
7. V <sub>TH2</sub>	23. E
8. POR - DELAY	24. P
9. POR	25. C.S <sub>IN</sub>
10. C <sub>HOLD</sub>	26. S
11. MODE SEL	27. C.S.
12. V <sub>DD</sub>	28. EA <sub>0</sub>
13. GND	29. EA - IN
14. ADC - REF	30. FLT - OUT
15. ADC - OUT	31. FLT - IN
16. PRK - ADJ	32. DAC - OUT

#### PRELIMINARY DATA SHEET

#### **ELECTRICAL CHARACTERISTICS**

Unless otherwise specified, these specifications apply over  $V_{cc}$  supply voltage of 10.8V to 13.2V,  $V_{DD}$  supply voltage of 4.75V to 5.25V and ambient temperature of 0° to 70°C. (Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature).

Parameter	Symbol	mbol Test Conditions		LX3187		Units
raidilletei	Sylliooi	Test conditions	Min.	Тур.	Max.	Office
Power Consumption						
V <sub>cc</sub> Supply Current	l <sub>vcc</sub>	Mode = HIGH, I <sub>MOTOR</sub> = 0		15 00	25	mA
Output Stage Bias Current	I <sub>BO</sub>	Mode = HIGH, I <sub>MOTOR</sub> = 0		(P sdon)	Chicago i	mA
Bias Current Temp Coefficient	L. INS	qual back and	(9 soon	neithba	Voltage	%
V <sub>DD</sub> Supply Current	I <sub>VDD</sub>	Mode = HIGH, I <sub>MOTOR</sub> = 0	- 90	3	bsoJ ta	mA
Output Disable Mode Current (12 & 5V)	l <sub>vcc</sub>	Mode = TRISTATE	nultHight A	TBD	orts@.http	mA
Park Quiecent Current	I <sub>PARK PWR</sub>	Mode = LOW, I <sub>MOTOR</sub> = 0	niel	7.5	sensil to	mA
Output Drive Section		76 = V	1145-5	nte	D spallely	/DQA
NPN Drive Current		$R_{\rm F}$ , $R_{\rm c}$ not connected, $P_{\rm x}$ = ( $V_{\rm cc}$ - 1V), $N_{\rm x}$ = 1V, $V_{\rm cc}$ = 10.8V	40	50	Change	mA
PNP Drive Current		$R_{\rm F}$ , $R_{\rm C}$ not connected, $P_{\rm X} = (V_{\rm CC} - 1V)$ , $N_{\rm X} = 1V$	40	55	Bies Cum	mA
Voltage Gain		S <sub>A</sub> / E <sub>AO</sub> or S <sub>B</sub> / E <sub>AO</sub>	9.8	10	10.2	V/V
Error Amplifier		A AO 8 AO	(qina DQA	) session	the Officet	Quip
Input Bias Current		Y OF 1001 = 341	(6)	10	100	nA
Output Source Current		V <sub>o</sub> = 6V	2	A 8 3) 19	510170	mA
Output Sink Current		V <sub>0</sub> = 2V	2	Seneno	t voltage	mA
Output Hi Level		$R_i = 10k \text{ to } V_{eff}$	6	Triarrius :	SHARE III	V
Output Lo Level		$R_{\rm i} = 10 \text{k to } V_{\rm REF}$	(gmA JC	A) Harri	9	V
Input Offset Voltage		$V_{\rm FA} = 4V$	-4	A DOM IS	4	mV
Open Loop Gain		R <sub>i</sub> = 10k	60	80	est of te	dB
Filter Buffer		76. N. 60. N. 60	1 00	BUILDINE.	(S) (S)	40 DAG
Input Bias Current		10 9 or 10 1 (1000 ± 3)	1	20	100	l nA
Input Offset Voltage		$R_i = 2k \text{ to } 4V$	-4	20	4	mV
Output Source Current		$V_0 = 6V$	2	308	eV sons	mA
Output Sink Current		$V_0 = 0$ V $V_0 = 0$ V	2	Hilliam Co	nal some	mA
Output Hi Level		$V_0 = 2V$ $I_0 = 2mA$	6	esvini) to	D Island A	V
Output Lo Level		$I_0 = 2mA$	0	STUD JUS	2	V
Slew Rate		10 - 2111/2		0.8	Z	V/uS
Gain		AMOUT ELL SE ELL VI		1	99033U	V/V
Power Monitor		YOF = 1,10,0, YF = 11,0 (18 = 38 Hailes F = 11	You	SUDON E	SWILCHIN	V/V
12V Threshold Voltage - V <sub>cc</sub>	V	Company Danier Davies	14040	10.05	10.00	1
	V <sub>TH1</sub>	Supply Ramp Down	10.10	10.35	10.60	٧
12V Hysterises - V <sub>CC</sub> 5V Threshold - V <sub>DD</sub>	V	Ramp Up Hysterises Supply Ramp Down	100	120	140	mV V
5V Hysterises - V <sub>DD</sub>	V <sub>TH2</sub>		4.475	4.575	4.675	
		Ramp Up Hysterises	45	60	75	mV
Input Resistance (V <sub>TH1</sub> or V <sub>TH2</sub> )		V <sub>TH1</sub>	-	10K	I agailor	Ω
POP Delay (pin 9)		V <sub>TH2</sub>		10K		Ω
POR Delay (pin 8) POR Output Saturation Voltage		C = 0.47µf	50	100	150	ms/µ
POR Discharge Current		I <sub>o</sub> = 500μA	1		0.8	V
POR Leakage Current			2		10	mА µА

# LX3187

## SERVO ACTUATOR DRIVE SUBSYSTEM

Baramata	Cumbal	Tost Conditions		LX3187		Units
Parameter	Symbol	Test Conditions	Min.	Тур.	Max.	Unit
/oltage Reference						
nitial Output Voltage		$I_{LOAD} = 0 \text{mA}, T_1 = 25 ^{\circ}\text{C}, V_{CC} = 12 \text{V}, V_{DD} = 5 \text{V}$	3.88	4	4.12	V
ine Regulation		$4.75 < V_{DD} < 5.25V, 10.8V < V_{CC} < 13.2V$		16	10	m۷
oad Regulation		0 to 3mA Load Change, V <sub>cc</sub> = 12V, V <sub>DD</sub> = 5V		- Inur	20	m\
emp Stability (note 2)		Modes = Modes = MOH   Louis = 0	3/11	20	opett stage	m\
otal Voltage Variation (note 2)		Line, Load, Temp	3.80	tso) and	4.2	V
Output Load Capacitance		0 =I Fight = strow	0	itren	1000	pF
Current Sense / ADC Amplifier		W. Just March = State   William	8 91) Insmu	shock o	ideald tu	oluO
urrent Sense Voltage Gain		V <sub>CM</sub> = 6V	3.92	4	4.08	V/
ADC Voltage Gain		V <sub>CM</sub> = 6V	2.9	3	3.1	VA
Gain Change	VIIIOT = 3	$V_{CM} = -0.8 \text{ to } V_{CC} + 0.8V$	-40	trier	Drive Curt	dE
nput Bias Current (ADC REF only)		F., R. not connected, R. = (V., 1 (V), N. = (V		20	100	n/
Output Offset Voltage (C.S Amp)		$V_{cs} = V_{sA} = V_{cc}/2$	-16	5	16	m'
Output Offset Voltage (ADC Amp)		$V_{ADC REF} = V_{REF}$ , $V_{CS} = V_{SA} = V_{CC}/2$	-12	3	12	m'
Output Hi Level (C.S Amp)		$R_i = 10K \text{ to } V_{ppp}$	V <sub>cc</sub> - 3		and the said	V
Output Lo Level (C.S Amp)		$R_{t} = 10K \text{ to } V_{pff}$	- 22	current	2	V
Offset Voltage Change		$V_{cM} = -0.8 \text{ to } V_{cc} + 0.8V$	-20	New Street	20	m'
Output Source Current (ADC Amp)	-	ADC - REF = 2.5V, ADC - OUT = 4V	2	3113111	Des I Det day	m/
Output Sink Current (ADC Amp)		ADC - REF = 2.5V, ADC - OUT = 1V	1	) in	rs I o l tu	m/
Output Hi Level (ADC Amp)		R <sub>1</sub> = 5k to GND	V <sub>pp</sub> -0.75	posite	V Supplies	V
Output Lo Level (ADC Amp)		R <sub>1</sub> = 5k to V <sub>prs</sub>	DO	cris	1	V
lew Rate, C.S. Amplifier		C <sub>1</sub> = 0, 10k to 2.5V		2.4		V/µs
lew Rate, ADC Amplifier		C <sub>1</sub> = 50pF, 10k to 2.5V		2.4	200100000	V/µs
ark Circuit				-	1/10/2003	Annual of
eference Voltage	1	$T_A = 25^{\circ}C$ , $I_{PRK,ADI} = 10\mu A$	0.62	0.69	0.76	V
eference Temp Coefficient		A7 PRK ALU		-9	30000	mV.
& P <sub>B</sub> Hold Off Current		Amb - A		Te Ite	On 1 Bd 91	m/
ark Adjust Input Current		000 = 1		1	es Lo Ltu	LIA
HOLD Current		4V < V <sub>HOLD</sub> < 10V			4	LIA
Output Drive Rds-on		V <sub>GS</sub> = 4V, I <sub>M</sub> = 100mA			30	Ω
rive Switching Frequency		$L_{M} = 1.25 \text{mH}, R_{M} = 5\Omega, V_{PRK} = 1V, V_{PRK,PWR} = 10V$		TBD	Aleman & C. mark	kH
A Source Drive Current		MODE-SEL = LO, I <sub>M</sub> = 100mA, V <sub>HOLD</sub> = 4V, V <sub>PRK PWR</sub> = 4V	5	100		m/
Sink Hold Current		MODE-SEL = LO, I <sub>M</sub> = 100mA	5			m/
ark/Normal/Disable Mode Select					to be stored	OF WE
Iormal Voltage Threshold		Parin United Arthresis	0.65 V	0.75 V <sub>DD</sub>	THE REAL PROPERTY.	V
isable Voltage Threshold		Salating Commit	0.4 <sub>VDD</sub>	0.75 V <sub>DD</sub>		V
ark Voltage Threshold	-		O. TVDD		0.35 V <sub>DD</sub>	V
nput Current				DD DD	±250	u/
8.0		L = 500uA		noblatuiz	Design Section 2	



## PRELIMINARY DATA SHEET

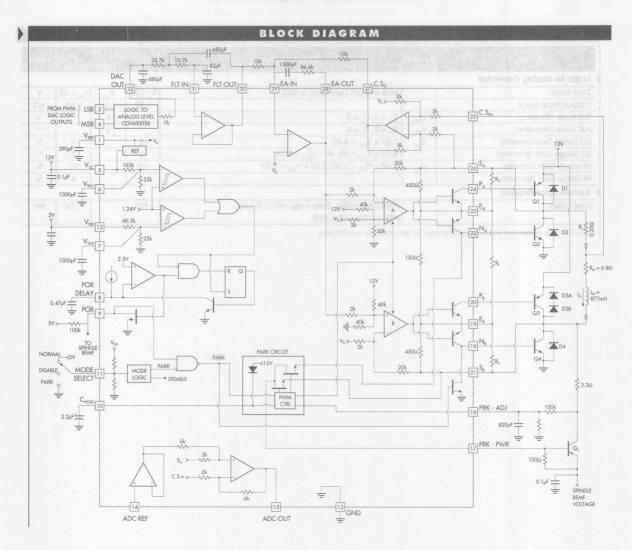
	ELEC	TRICAL CHARACTERISTICS (continue	d)			
Parameter	Sumbol			LX3187		
raidilletei	Sylliooi	Symbol Test Conditions			Max.	Units
Logic to Analog Converter		roll mostly made among	100 TO 10	240		
Zero Scale		MSB and LSB Duty Cycle = 50%	V <sub>pre</sub> 02	V <sub>REF</sub>	V <sub>pFF</sub> +.02	٧
Output Impedance			5.77	7.11	8.53	kΩ
Full Scale (Positive)	V <sub>FSP</sub>	$D_{M} = 1, D_{L} = 1$	-4VV- EX1/30.4	6	36001	٧
Full Scale (Negative)	V <sub>FSN</sub>	$D_{M} = 0, D_{L} = 0$		2		٧
LO Range Gain Linearity	G <sub>LO</sub>	3.6V < V <sub>FLO</sub> < 4.4V	-5		5	%
LO Range Gain Symmetry		3.6V < V <sub>FLO</sub> < 4V, 4V < V <sub>FLO</sub> < 4.4V	-2	n	2	%
HI Range Gain Linearity	G <sub>HI</sub>	4.4V < V <sub>FLO</sub> < 5.4V, 2.6V < V <sub>FLO</sub> < 3.6V	-10		10	%
HI Range Gain Symmetry			-4		4	%
System Specification	ALL IT	And the second	4		E 1/300	
Total Offset		PWM DAC, Buffer, Error Amp, ADC C.S Amp,	-100		+100	mV
		MSB = 50%, LSB = 50%	-<7			

Note 2. This parameter although guaranteed is not tested in production.



# LX3187

## SERVO ACTUATOR DRIVE SUBSYSTEM





	7	PIN DESCRIPTION
Pin	#	Description
$V_{REF}$	1	Reference voltage output. A 390pF capacitor connected from this pin to GND results in maximum stability Reference output has no short circuit protection and must not exceed it's maximum current rating.
NC	2	No connect.
LSB	3	Lesser significant input data to PWM D to A converter; LSB has 1/32 the weight of MSB on DAC OUT.
MSB	4	More significant input data to PWM D to A converter.
V <sub>cc</sub>	5	12V supply voltage. A high freq by pass capacitor is normally connected between this pin and GND.
V <sub>TH1</sub>	6	12V por threshold voltage. An internal resistor divider from $V_{\rm cc}$ to GND sets the 12V por threshold at 10.35V typ. An external resistor divider can be used to change this threshold. A small ceramic capacitor connected from this pin to GND helps to reduce high freq noise.
V <sub>TH2</sub>	7	5V por threshold voltage. An internal resistor divider from $V_{cc}$ to GND sets the 12V por threshold at 4.6V typ. An external resistor divider can be used to change this threshold. A small ceramic capacitor connected from this pin to GND helps to reduce high freq noise.
POR - DELAY	8	A capacitor from this pin to ground programs por delay time when both supplies are above por threshold plus hysterises, delay circuit is activated and "POR OUTPUT" pin switches high after the delay time. The relationship between delay time and delay capacitor is: $T_D = C_D * 100,000$ Sec. (typ).
POR	9	A logic level output that switches to low position when either supplies are below their threshold points. When both supplies are above POR thresholds plus hysterises voltage, this pin switches from LO to HI after the programmed delay time. Park mode is automatically activated when this pin is switched LO.
C <sub>HOLD</sub>	10	This pin is normally pulled HI through an internal diode to $V_{cc}$ . Connecting a capacitor from this pin to ground provides sufficient voltage for park logic circuit when $V_{cc}$ is inactive.
MODE SELECT	11	A tri-state logic input that selects mode of operation.  Normal Mode = HI  Sleep Mode = OPEN
	PITTIN	Park Mode = LO // DIO - TIF
V <sub>DD</sub>	12	5V supply voltage. A high freq by pass capacitor is normally connected between this pin and GND.
GND	13	Ground pin of the IC. This pin is connected to substrate.
ADC - REF	14	This pin is normally connected to mid scale point of ADC reference. Input bias current of this pin is typicall 100nA.
ADC - OUT	15	The output pin of the differential amplifier. This pin is normally fed back to ADC. The relationship between this pin and "ADC REF" pin is given by: ADC OUT = $\pm$ 3 * $I_M$ * $R_S$ + ADC - REF.
PRK - ADJ	16	A resistor divider from $S_B$ to GND connected to this pin programs park voltage.
PRK - PWR	17	Spindle motor back EMF provides supply voltage to park circuit power driver via this pin.



		PIN DESCRIPTION (continued)
Pin	#	Description
N <sub>B</sub>	18	This pin is connected to the base of external NPN transistor.
E <sub>B</sub>	19	Emitter of B amplifier
P <sub>B</sub>	20	This pin is connected to the base of external PNP transistor.
S <sub>B</sub>	21	This pin is connected to the other side of the voice coil and the junction of the 2nd pair of external transistors. Internally this pin acts as the inverting path for "B" amplifier.
GMCN <sub>A</sub> a raq a	22	This pin is connected to the base of external NPN transistor.
AND THE EAST OF THE SAME	23	Emitter of A amplifier. Connecting resistor $R_E$ and $R_C$ such that $R_C = 4.5 \text{ X } R_E$ as shown on block diagram, increases the current to output transistor bases.
P <sub>A</sub>	24	This pin is connected to the base of external PNP transistor.
C.S <sub>IN</sub>		This pin acts as positive sense input of the voltage across the current sense resistor during normal mode of operation.
blodeen S <sub>AC</sub> aved	26	This pin is connected to the junction of the external sense resistor and the voice coil. This pin is internally connected to the inverting side of C.S. differential amplifier and feedback for "A" amplifier.
o 2.2 shold points. When a LO to LE after the		Output of the current sense amplifier. This pin provides motor current feedback to the error amplifier relationship between output voltage and motor current is given by: $V_{\text{C.S.OUT}} = \pm 4 * I_{\text{M}} * R_{\text{S}} + V_{\text{REF}} \qquad \text{where: } I_{\text{M}} = \text{MOTOR CURRENT} \qquad ; \qquad R_{\text{S}} = \text{CURRENT SENSE RESISTOR}$
E.A o	28	Error amplifier output pin. An external compensation network is placed between this pin and the "E.A. IN" pin based on the voice coil parameters. This sets the closed loop transconductance bandwidth of the amplifier.
EA - IN	29	Inverting input of the error amplifier. This pin acts as the summing node for the "C.S. OUTPUT VOLTAGE" and filtered command voltage "FILTER OUT."
FLT - OUT	30	Output pin for buffer amplifier. This pin acts the the filtered output of "DAC OUTPUT VOLTAGE." The amplifier is typically configured as a third order Butterworth low pass filter.
FLT - IN	31	Input pin for buffer amplifier.
DAC - OUT	32	PWM DAC output pin. The output impedance of this pin (typ 7.11K) and a capacitor from this pin to GND creates real pole of the 3rd order low pass filter.



## PRELIMINARY DATA SHEET

#### APPLICATION INFORMATION

#### DIGITAL TO ANALOG CONVERSION

The LX3187 includes a logic to analog conversion circuit with the ability to trim the zero scale command voltage for an overall system offset voltage of less than 5% of the total full scale current. The simplified schematic of this section is shown in Figure 1. The MSB and LSB logic output words are connected to the LX3187 "MSB and "LSB" pins. The bottom current sources are on only during the off time of the inputs, causing the average voltage at the capacitor connected to the "DAC OUT" pin to change as the duty cycle of the logic inputs change. The 12-bit output word should be encoded into MSB and LSB logic signals whose duty cycle is given by:

Duty Cycle (MSB) 
$$\equiv D_M = \frac{M_6}{64}$$
;  
Duty Cycle (LSB)  $\equiv D_L = \frac{32 + L_5}{128}$ 

where: 12 bit word =  $M_cL_c$ 

The average DAC OUTPUT which is given by the output of the 3rd order low pass filter, is given by:

$$V_{\text{FLO}} - V_{\text{REF}} = V_{\text{FS}} \left[ 2 \left( \frac{32}{33} D_{\text{M}} + \frac{1}{33} D_{\text{L}} \right) - 1 \right]$$

where V

 $V_{_{\mathrm{FS}}}$  = full scale voltage (2V typ)  $V_{_{\mathrm{REF}}}$  = reference voltage (4V typ)  $V_{_{\mathrm{FLO}}}$  = filter output (pin 30)

Assuming  $V_{REF} = 4v$  results in full scale values of:

$$\begin{aligned} & V_{\text{FLO}} = 6V & & \text{for} & & D_{\text{M}} = D_{\text{L}} = 1 \\ & V_{\text{FLO}} = 4V & & \text{for} & & D_{\text{M}} = D_{\text{L}} = 1/2 \\ & V_{\text{FLO}} = 2V & & \text{for} & & D_{\text{M}} = D_{\text{L}} = 0 \end{aligned}$$

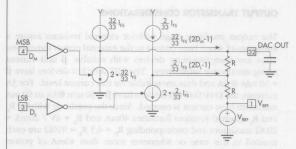


FIGURE 1 — LOGIC TO ANALOG CONVERTER SIMPLIFIED SCHEMATIC

#### CARRIER RIPPLE FILTER

The preferred way to remove the carrier ripple is by configuring the on-chip buffer amplifier as a Salen Key 3 pole Butterworth low pass filter, as shown in the block diagram.

The normalized transfer function of such a filter is:

$$\frac{1}{\left(\frac{S}{W_{\odot}}\right)^{3} + 2\left(\frac{S}{W_{\odot}}\right)^{2} + 2\left(\frac{S}{W_{\odot}}\right) + 1}$$

If the clock frequency is 40MHz then the frame rate and lowest carrier ripple frequency of the MSB and LSB signals is 40MHz/64 = 625kHz. Assuming  $f_{\rm o}$  is chosen to be 35 kHz, then  $W_{\rm o}=2\pi$  \* 35 \*  $10^3$ . For an overall system bandwidth of 500 Hz, the filter introduces only a -2° phase shift yet it rejects the 625 kHz carrier freq by -74 dB.

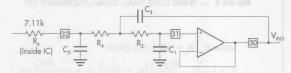


FIGURE 2 — 3RD ORDER SALEN KEY LPF FILTER

The component values selected here set the corner frequency at 35kHz.

$$R_4 = 35.7 \text{ k}\Omega (1\%)$$
  $R_2 = 10.7 \text{ k}\Omega (1\%)$   
 $C_5 = C_3 = 680 \text{pF} (5\%)$   $C_1 = 82 \text{ pF} (5\%)$   
 $R_6 = \text{The vnin equivalent resistance of the internal circuit } (7.11 \text{k typ})$ 

If a different cutoff frequency is desired, the values of the capacitors can be scaled proportionally and Butterworth response will be retained if the R values are kept constant at the values given. Below is the transfer function of the above filter.

$$\left\{ S^{3}R_{6}C_{5}R_{4}C_{3}R_{2}C_{1} + S^{2} \left( R_{6}C_{5}R_{2}C_{1} + R_{6}C_{5}R_{4}C_{1} + R_{4}C_{3}R_{2}C_{1} + R_{6}C_{3}R_{2}C_{1} \right) + S \left( R_{6}C_{5} + R_{6}C_{1} + R_{4}C_{1} + R_{2}C_{1} \right) + 1 \right\}$$

## PRELIMINARY DATA SHEET

#### APPLICATION INFORMATION (continued)

# CLOSED LOOP TRANSCONDUCTANCE AND FREQUENCY RESPONSE

Figure 3 shows the small signal model of the VCM servo loop.

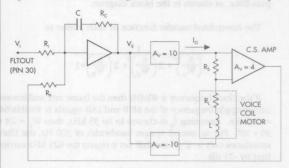


FIGURE 3 — SERVO LOOP SMALL SIGNAL EQUIVALENT CKT

Assume: 
$$R_L = 5\Omega$$
,  $L = 1.25 \text{mh}$ 

$$V_E = \left(-\frac{V_I}{R_I} - \frac{4I_oR_s}{R_F}\right) \left(R_c + \frac{1}{SC}\right), I_o = \frac{20V_E}{R_s + R_L + SL}$$

$$\therefore \left(\frac{R_s + R_L + SL}{20}\right) I_o = \left(\frac{V_I}{R_I} - \frac{4I_oR_s}{R_F}\right) \left(R_c + \frac{1}{SC}\right)$$

$$\frac{I_o}{V_I} = \left(\frac{R_c + \frac{1}{SC}}{R_I}\right) * \frac{20R_F}{\left[R_F (R_s + R_L + SL) + 80R_s \left(R_c + \frac{1}{SC}\right)\right]}$$

$$= \frac{20\frac{R_F}{R_I}}{80R_s + \frac{R_F}{SC} \left(1 + \frac{L}{R_s + R_L} S\right) \left(R_s + R_L\right)}$$

Thus the static closed loop transfer function  $(S \rightarrow 0)$  is:

$$\frac{I_o}{V_I} = \frac{R_F}{4R_SR_I}$$

And since  $V_1$  is  $\pm V_{REF}/2$  ( $\pm$  2.0V typ of full scale), then  $\pm$   $I_0$  full scale =  $R_F/(2R_S^2R_I)$  and for  $I_0$  =  $\pm$  2A,  $R_S$  = 0.25 $\Omega$  is a good choice, (i.e. 0.5V across the sense resistor):

$$\frac{R_{\rm F}}{R} = 2 * 2R_{\rm S} = 1$$

Now for considerations of closed loop bandwidth, transient response and the required frequency compensation network  $R_{\rm c}$  and C, it is usually advisable to set  $R_{\rm c}C = L/(R_{\rm s} + R_{\rm c})$ , i.e. match the compensation and load time constants so the closed loop response is dominantly that of a single pole network:

$$\therefore \frac{I_{o}}{V_{i}} = \frac{20 \frac{R_{F}}{R_{i}}}{80R_{s} + SR_{F} (R_{s} + R_{L}) C}$$

$$= \frac{R_{F}}{4R_{s} R_{i} \left(1 + S \frac{R_{F} (R_{s} + R_{L}) C}{80 R_{s}}\right)}$$
so that  $f_{o} = \frac{80R_{s}}{2\pi R_{s} (R_{s} + R_{s}) C}$ 

where fo is the closed loop -3db bandwidth.

Assuming  $R_F = R_I = 10k$ , for  $f_O = 20kHz$ , the value of C is calculated using:

$$C = \frac{80*0.25}{10*10^3 (0.25+5)*2\pi*20*10^3} , C = 0.0033 \mu f$$
 and since  $R_c = \frac{L}{(R_c + R_c) C}, R_c = \frac{1.25*10^3}{5.25*0.0033*10^6} \cong 72 k\Omega$ 

#### **OUTPUT TRANSISTOR CONSIDERATIONS**

The output predriver stage without external resistors assure a minimum of 40mA base current to the external power transistors. Thus any complimentary devices with suitable  $\beta$  and current rating usually are satisfactory. The MJE 200/210 devices have  $\beta$  = 50 min @ 2A and thus are suitable for this current level. For 3A currents, the D44/D45 HII devices have  $\beta$  = 50 min @3A so 60 mA minimum base current is needed. Since the predriver without  $R_c$  and  $R_g$  external resistors furnishes 40mA and  $R_g$  = 4V / 20mA =  $200\Omega$  maximum and corresponding  $R_c$  = 4.5  $R_g$  =  $910\Omega$  are each needed in this case or whenever more than 40mA of power transistor base current is needed.

Suitable surface-mount power devices include: BCX 68-69, BCP 68-69, 2SD 2098-2SB 1386, MJD 44HII-45HII, MJD 200-210.



#### PRELIMINARY DATA SHEET

#### APPLICATION INFORMATION (continued)

#### **CURRENT SENSE AMPLIFIER**

The additional current sense amplifier is used to provide actual measured motor current feedback to the controller. It is ordinarily used with an analog to digital converter that uses the same  $V_{\text{REF}}=4V$  as the 3187 for its full scale most positive reference and ordinarily 1V ( $V_{\text{REF}}/4$ ) as its least positive reference. Thus the voltage for 0 current at half scale is  $[V_{\text{REF}}+(V_{\text{REF}}/4)]/2=2.5V,$  which should be "ADC REF" of the 3187. This can be obtained by two equal value resistor divider of convenient value such as  $10 k\Omega$  between the most positive and least positive reference voltages, since the ADC REF pin is buffered for high impedance inputs.

$$V_{\text{REF}} = \text{MOST POSITIVE ADC REF.}$$

10.0k

10.0k

 $V_{\text{STF}}/4 = \text{LEAST POSITIVE ADC REF.}$ 

Then Diff-Amp out voltage = ADC REF ±31 Rc.

#### **POWER-ON RESET**

The  $\overline{POR}$  is an open collector output that switches low when either  $V_{cc}$  or  $V_{DD}$  are below their thresholds of 10.3V and 4.6V respectively. At the same time, an internal transistor discharges the PORDELAY capacitor. When power returns both comparators are above their thresholds, the POR latch gets reset and allows the delay capacitor to charge up via an internal current, causing a delay of 100 ms/µf typ before the POR switches HI again (POR pin requires a maximum 100k pull up resistor). In our previous example,  $0.47\mu f$  capacitor allows a typical of 100ms which is adequate for most applications.

#### MODE SELECT FUNCTION

The figure below shows the internal logic circuitry for "Mode Select." When this pin is set low, both comparators output switch LO and the output of park "AND" gate goes HI which enables the park function. If the mode select pin is left open, comparator "A" switches LO but comparator "B" is HI which enables the "disable" mode. In this mode all functions are disabled except for the POM circuit, PWM DAC and the PARK circuit. When the mode select pin is HI, both "AND" gates are LO and the device resumes its normal operation.

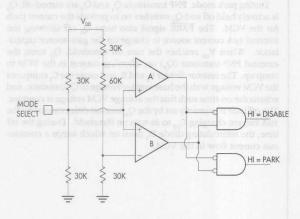


FIGURE 5 — MODE SELECT COMPARE LOGIC CIRCUITRY

#### PRELIMINARY DATA SHEET

#### APPLICATION INFORMATION (continued)

#### PARK CIRCUIT

The LX3187 has a unique "switching mode" PARK circuit which allows in excess of 200mA PARK current with less package power dissipation when compared to the standard linear mode circuits used in most VCM controllers.

The voice coil head park is initiated by loss of either supplies which is indicated by the  $\overline{POR}$  pin switching LO or when mode select is pulled low. Referring to the main block diagram, when either of the " $\overline{POR}$ " or "mode select" pins are set low, PARK switches high and enables the park circuit shown in figure 6.

During park mode, PNP transistors  $Q_1$  and  $Q_2$  are turned off,  $Q_4$  is actively held off and  $Q_2$  switches on to provide the current path for the VCM. The PARK signal also turns  $Q_c$  off allowing the internal 1µA current source to charge up the gate-source capacitance. When  $V_{cs}$  reaches the turn on threshold,  $Q_N$  turns the external PNP transistor  $(Q_p)$  on, allowing current in the VCM to ramp up. The resistor divider  $R_1$  and  $R_2$  and capacitor  $C_1$  compares the VCM voltage with the base emitter voltage of  $Q_A$  transistor, and adjusts the on-time such that the average VCM voltage is constant. The off time is primarily set by the  $Q_N$  turn-on delay caused by the 1µA current charging  $C_{cs}$  to its turn on threshold. During the off time, the recirculating diode  $D_4$  turns on which keeps a continuous current flow in the VCM.

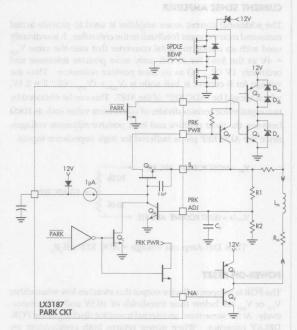


FIGURE 6 — PARK CIRCUIT SIMPLIFIED CIRCUIT





## HALL-LESS SPINDLE MOTOR DRIVER

THE INFINITE POWER OF INNOVATION PRELIMINARY DATA SHEET

#### DESCRIPTION

The LX3191B is a monolithic BiCMOS IC designed to control speed and commutation of a Hall-less 3-phase motor used in many high-performance data storage devices. Special circuitry allows accurate digital commutation control in conjunction with precise current wave shaping that allows substantial reduction in acoustic motor noise. This device includes a serial interface that enables the user to select different modes of operation by a 16-bit word with a direct interface to the

microcontroller. High-speed operation is achieved through bipolar start-up for increased starting torque. PWM operation during start-up to minimize power dissipation is available. The LX3191B is designed to drive external low side n-channel FETs, and high side p-channel FETs, such as the ones available as complimentary P and N channel devices in 8-pin SOIC packages as shown in the product highlight. A full evaluation board is available for application development.

#### KEY FEATURES

## SERIAL DATA CONTROL INTERFACE

CONTROLS ARE

- Trapezoidal shape motor current
- · Brake function via serial interface & power down
- Start-up start advancing
- External / Internal BEMF commutation
- PWM / Linear Mode

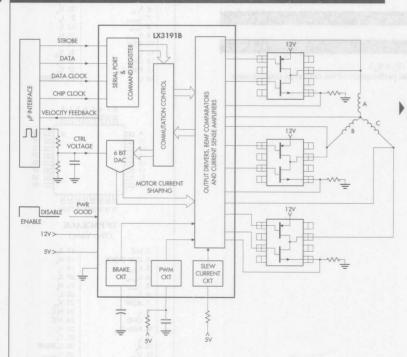
#### ■ EXTERNAL POWER DRIVE ALLOWS:

- · Higher efficiencies due to much smaller available R on resistance (now available from many sources)
- Higher headroom voltage allows smaller motor design
- BIPOLAR PWM START REDUCES START UP POWER DISSIPATION OF LOW SIDE FETS
- TRAPEZOIDAL CURRENT SHAPE CONTROL REDUCES MOTOR ACOUSTIC NOISE, ELMINATES SNUBBER
- SEPARATE SENSE RESISTORS COMPENSATE FOR EXTERNAL TRANSISTOR MISMATCH AND ACCURATE COMMUTATION CONTROL
- D POWER GOOD, BRAKE DELAY, EXTERNAL FREQUENCY PWM OFF TIME CONTROL

#### APPLICATIONS

- HIGH-PERFORMANCE / HIGH-SPEED MULTIPLE PLATTER 31/2" & 51/4" DRIVES. (i.e. 7200 rpm, 10 platters)
- EVALUATION BOARD AVAILABLE

#### PRODUCT HIGHLIGHT



0 to 70

#### PACKAGE ORDER INFORMATION Plastic PLCC TF Plastic TQFP T (°C) 28-pin 32-pin

LX3191BQ

FOR FURTHER INFORMATION CALL (714) 898-8121

LX3191BTF

## LX3191B

## HALL-LESS SPINDLE MOTOR DRIVER

## PRELIMINARY DATA SHEET

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Note 1. Exceeding these ratings could cause damage to the device. All voltages are with respect to Ground. Currents are positive into, negative out of the specified terminal.

Note 2. Pin numbers refer to PLCC package.

All of the above assume no ambient airflow.

#### THERMAL DATA

#### Q PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT,  $\theta_{_{JA}}$ 

TF PACKAGE:

THERMAL RESISTANCE-JUNCTION TO AMBIENT,  $\theta_{j_A}$ 

Junction Temperature Calculation:  $T_J = T_A + (P_D \times \theta_{JA})$ . The  $\theta_{IA}$  numbers are guidelines for the thermal performance of the device/pc-board system.

70°C/W

**PACKAGE PIN OUTS** 4 3 2 1 28 27 26 25 24 22 21 20 12 13 14 15 16 17 18 **Q PACKAGE** (Top View) 15. S<sub>A</sub> 16. V<sub>CTRL</sub> 1. V<sub>RETRACT</sub>
2. POWER GOOD 3. B<sub>DLY</sub>
4. V<sub>DD</sub>
5. CHIP CLOCK 19. 5 6. F<sub>COM</sub> 7. S<sub>STROBE</sub> 20. H 21. L<sub>8</sub> 22. S<sub>8</sub> 8. S<sub>DATA</sub>
9. S<sub>CLOCK</sub>
10. SLEW 23. H<sub>8</sub> 24. L<sub>c</sub> 25. V<sub>cc</sub> 11. I<sub>c</sub> 12. GND 26. H<sub>c</sub> 27. C<sub>T</sub> 28. C<sub>T</sub> DRIVE 13. PWM T<sub>OFF</sub> 14. I<sub>B</sub> 87654321 RARABARA 13 H 14 H 15 H 16 H HHHHHHH 17 18 19 20 21 22 23 24 TF PACKAGE (Top View) 17. S<sub>C</sub> 18. H<sub>A</sub>

1. N.C.

2. CHIP CLOCK

18. H<sub>A</sub>

19. I<sub>a</sub>

4. S<sub>STROBE</sub>

20. S<sub>b</sub>

5. S<sub>DATA</sub>

21. H<sub>b</sub>

6. S<sub>CLOCK</sub>

7. SLEW

23. V<sub>CC</sub>

8. I<sub>c</sub>

9. GND

10. PWM T<sub>OFF</sub>

11. I<sub>b</sub>

27. C<sub>T</sub>

12. S<sub>A</sub>

28. C<sub>T</sub> DRIVE

13. V<sub>CTR</sub>

14. I<sub>b</sub>

30. POWER (1. I<sub>b</sub>

31. B<sub>DYY</sub>

16. I<sub>a</sub>

32. V<sub>DD</sub>

## HALL-LESS SPINDLE MOTOR DRIVER

## PRELIMINARY DATA SHEET

	Sbal	Recommend	Conditions	Units		
Parameter	Symbol	Min. Typ.		Max.	Ullits	
V <sub>DD</sub> Voltage		4.75		5.25	V	
V <sub>CC</sub> Voltage, V <sub>RETRACT</sub>		10.8		13.2	٧	
V <sub>CTRL</sub> Voltage	AS B or Wind, the till deliver	Bo Brand C		V <sub>DD</sub>	V	
PWM Timing Capacitor	C <sub>T</sub>	1000pF		0.01µF	Section of	
PWM Timing Resistor	R <sub>T</sub>	10		100	kΩ	

#### ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, these specifications apply over the operating ambient temperature range of  $0^{\circ}\text{C} \leq \text{T}_{\lambda} \leq 70^{\circ}\text{C}$  and  $V_{DD} = 5\text{V}$ ,  $V_{CC} = 12\text{V}$ . Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Pin numbers refer to PLCC package.

Parameter	Symbol	Test Conditions		LX3191B		Unit
raidilletei	Sylliooi	rest conditions	Min.	Тур.	Max.	Oilit
Logic and Power Good Input Sec	tion (Pin	s 2, 5, 7, 8, 9)				
High Input Voltage	V <sub>IH</sub>	Way Variable	2.4	100	Stee Creek	٧
High Input Current	I <sub>IH</sub>	2.4 < V <sub>IH</sub> < 5.5V		20	200	nA
Low Input Voltage	V <sub>IL</sub>			onsi so	0.8	٧
Low Input Current	I <sub>IL</sub>	V <sub>IL</sub> = 0.4V	spirital	20	200	nA
Input Capacitance		Pins 5, 7, 8, 9		3		pF
		Pin 2		10		pF
Clock Frequency	F <sub>CLK</sub>	Pin 5		PHILA.	10	MHz
F <sub>com</sub> Output Section (Pin 6)		With a W				
High Output Voltage		I <sub>o</sub> = 1mA	2.4	and the same	Tale 2 s	V
Low Output Voltage		I <sub>o</sub> = 1mA	Sam Danie	Later Samuel	0.4	٧
Retract Section (Pin 1), Vpp = Vcc	= 0V	The second of th			about states	
Input Current		V <sub>RETRACT</sub> = 13.2V		1.2	1.75	mA
Brake Delay Section (Pin 3)		VI = V Author L = 100 IA V = IV	(2 stool )	- fragmid	entro Edi	serio Ĉ
Charge Current	I <sub>CH</sub>	Pin 2 = HIGH	300	700	850	μА
Discharge Current	I <sub>D1</sub>	Pins 18, 21, 24 OPEN; Pin 2 = LOW, Pin 3> 7.7V, $V_{cc} = V_{pp} = 0V$		72		μА
	I <sub>D2</sub>	Pins 18, 21, 24 OPEN; Pin 2 = LOW, Pin 3 $\leq$ 6V, $V_{cc} = V_{DD} = 0V$		10	20	μА
Retract Delay Constant	T <sub>D1</sub>	$V_{TH} < V_{BRAKE} < 10.5V$	15	60		ms/µ
Peak Charge Voltage	V <sub>p</sub>	76 = 1500 E \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	11.35	V <sub>cc</sub> -0.3		٧
Threshold Voltage	V <sub>TH</sub>	Unear Morta, I = 300µV, V.,. = 3V	6.7	7	7.5	٧
Slew Section (Pin 10) (Note 4)		PWW Morks, V <sub>c</sub> = 2V				
Slew Input Impedance	R	100μA ≤ I <sub>SLEW</sub> ≤ 300μA	2.5	3.8	5.5	kΩ
Output Current to Slew Current Gain	K	100μA ≤ I <sub>SLEW</sub> ≤ 300μA	1.5	1.8	2.2	chrito.
Speed Control Section (Pin 16)		(, 23)	n (Pins	y Sectio	qqu2 t	Pawe
Operating Voltage Range	V <sub>CTRL</sub>	1 × 2008	0	103	3.5	V
Input Bias Current	CIRC	1V < V <sub>CTRI</sub> < 5.5V	-2	źna	nu01dge	μА
Control Voltage Shutdown Threshold	V <sub>OFS</sub>	No. of the second secon	50			mV
Control to C.S. Gain, PWM and Linear	G	Gain = $\Delta V_{PIN16} / \Delta V_{CS,I} 0.5V < V_{CTRL} < 3.5V$	5.1	5.9	6.8	V/V
Gain Matching (Note 5)		Between channels A, B, C; 0.5V < V <sub>CTRL</sub> < 3.5V	-10	01:00	+10	%
Gain Matching		Between PWM to Linear Mode, 0.5V < V <sub>CTRI</sub> < 3.5V	0	= 0000	6	%

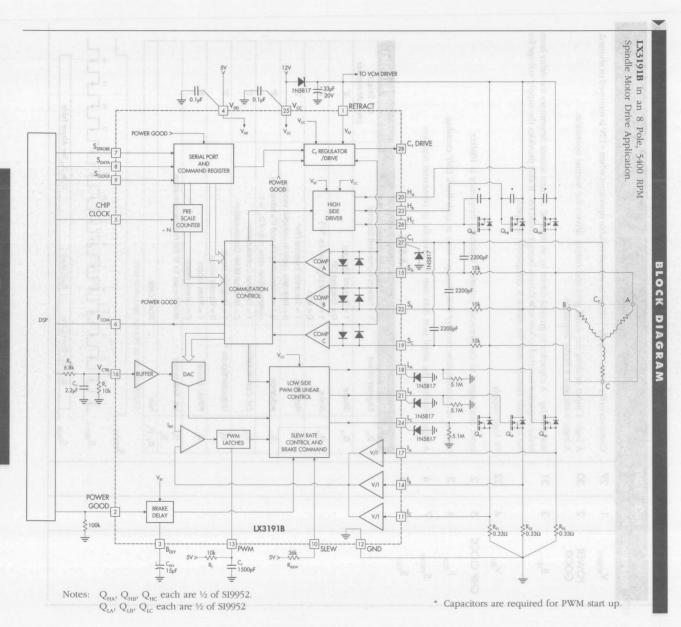
# LX3191B

## HALL-LESS SPINDLE MOTOR DRIVER

Parameter  PWM Section (Pin 13)  Winimum Off Time  Comparator Bias current  Discharge Current  Upper Threshold Voltage  Lower Threshold Voltage	T <sub>OFF MIN</sub>	Test Conditions  During charge time, V <sub>PRVM</sub> = 2.5V	Min.	Тур.	Max.	Unit
Winimum Off Time Comparator Bias current Discharge Current Upper Threshold Voltage Lower Threshold Voltage		During charge time, V = 9.5V			posli	V., Ve
Comparator Bias current Discharge Current Upper Threshold Voltage Lower Threshold Voltage		During charge time V = 9.5V				1
Discharge Current Upper Threshold Voltage Lower Threshold Voltage		During charge time V = 9.5V				μs
Upper Threshold Voltage Lower Threshold Voltage	IDP	Daining Change tille, tpWM - 2101	-3	-0.8	0.5	μA
Lower Threshold Voltage			2.5	5	7	mA
	V <sub>U</sub>	Ar a	2.9	3	3.1	V
Name Waltage Lavi	V,			1		٧
Clamp Voltage, Low		I <sub>SOURCE</sub> = 100µA	0.25	0.5	0.6	V
C. Pin (Pin 27)	-	SOURCE		-	and a contract	
Input Impedance		V <sub>G</sub> < 10.5V	160			ΓκΩ
Back EMF Comparators (Pins 15, 1	10 00)	Transfer and the form and the property of the party of th	100	allkan s	Lweetlo	1/22
	-	L EV C 0/ 45	trice property	Prince Control	45	1
nput Offset Voltage	V <sub>IO</sub>	$4.5V < C_T < (V_{cc}-1.5)$	and the same	1000 000	±15	mV
Clamp Voltage	V <sub>CLP</sub>	$I = \pm 2mA$	0.6	4500	1.2	V
InputCurrent	1	$ V_{IN}  < 0.5V, 4.5V < C_{T} < V_{CC} - 1.5V$	-1.5		1.5	μA
Maximum Input Current	IMAX	I LEGIS I NORTH STORY OF THE ST		-	±10	m/
Current Sense Comparators (Pins	11, 14,	17)	ave smelin to	DOM: INTE	u i ulie	uigu-
Input Bias Current	I <sub>BCS</sub>	$0V < V_{cs} < 0.7V$	-135	380	-65	LIA.
Input Voltage Range			-0.3	OBS	4	V
Operating Voltage Range			0	- 19	V <sub>CS MAX</sub>	V
Maximum Current Sense Voltage	V <sub>CS MAX</sub>	$V_{CTRL} = 3.2V, V_{DD} = 4.75V$	0.48	0.55	0.61	V
High Side Output Driver Section				3.30	IN LIGHT	, sugn
Output Voltage Low	Ì	Ι=100μΑ		0.95	1.25	IV
Output Voltage High		I = -50µA	11.5	V <sub>PIN1</sub> -0.2		V
Output Source Current (turn off)		V <sub>OH</sub> = 10V	400	500	Turking and	μА
Output Sink Current (turn on)		V <sub>OL</sub> = 10V	170	250	NY PERCENT	μА
	Pins 18	21, 24) Note 5. See Pin Description Section for I <sub>SLEW</sub> formu		Hoke	N Judje	- WOI
Output HI Voltage	1113 10,	Linear Mode, I <sub>SIFW</sub> = 100µA	10	V 00	1200 12	IV
Sulput HI voltage	114		9	V <sub>cc</sub> -0.2	71151714	V
Output Source Current (Note 5)	1	PWM Mode, I <sub>SOURCE</sub> = 5mA	150	V <sub>cc</sub> -1.5	220	UA
Suput source current (Note 5)	I <sub>SLH</sub>	Linear Mode, I <sub>SLEW</sub> = 100µA, V <sub>OH</sub> = 1V	450	200	660	1
	WE V	Linear Mode, I <sub>SLEW</sub> = 300µA, V <sub>OH</sub> = 1V		05	000	μА
Output I O Voltage		PWM Mode, V <sub>OH</sub> = 5V	10	25	0.5	m/
Output LO Voltage	Par The	Linear Mode, I <sub>SLEW</sub> = 100µA		0.1		
2. 1- 1. 6: -1. 6:		PWM Mode, I <sub>SINK</sub> = 5mA	450	1.0	1.50	V
Output Sink Current (Note 5)	I <sub>SLL</sub>	Linear Mode, I <sub>SLEW</sub> = 100µA, V <sub>OL</sub> = 3V	150	200	220	μА
	-	Linear Mode, I <sub>SLEW</sub> = 300µA, V <sub>OL</sub> = 3V	450	- 00	660	μА
2.1.1.6		PWM Mode, V <sub>OL</sub> = 2V	15	20	10111116	m/
Output Current Source to Sink Ratio		100μA < I <sub>SLEW</sub> < 300μA	1	sphists	1.25	µA/L
Output Off Leakage Current		$P_{GOOD} = LO, V_{BRAKE} > 7.7V, V_{OL} = 0.5V, V_{CC} = V_{DD} = 0V$	dis 5 manu	Wsi2 of 1	200	nA
Power Supply Section (Pins 4, 25)			(8th 16)	oi.Sectio	tino3 b	Spec
V <sub>DD</sub> Supply Current		$P_{GOOD} = 1$		10	12	m/
		P <sub>GOOD</sub> = 1		10	12	m/



# HALL-LESS SPINDLE MOTOR DRIVER RELIMINARY DATA SHEET



LINFINITY

Pin Name	PLCC Pin #	TQFP Pin #	Descrip	otion					
V <sub>RETRACT</sub>	1	29	Connec	ts to the retract suppl	y voltage to ensure reliable operation when	+12V is removed or shorted			
POWER GOOD	2	30	A logic A logic	logic 1 input enables the serial port and output drivers for normal operation. logic 0 initiates a brake sequence.					
B <sub>DLY</sub>	3	31	brake se	Brake Delay - A capacitor to ground driven by an internal current source determines the delay fro orake sequence initiated to low side drivers being turned on. It also provides the supply voltage fine low side drivers until the motor is completely stopped.					
V <sub>DD</sub>	4	32	5V logic	supply.	11 1 1 1 1 1 1 1				
CHIP CLOCK	5	2	Input cl	ock signal to the pre	e-scale counter. Maximum frequency is 10	MHz.			
F <sub>COM</sub>	6	3	Output	of commutation cou	inter that changes state at each Back EMF	crossing.			
S <sub>STROBE</sub>	7	4	A logic	0 latches the serial p	port data into the prescale or command re	egisters			
S <sub>DATA</sub>	8	5			TABLE 1				
			Bit #	Description	Command Register	Prescale Register			
	V	1	D <sub>15</sub>	Register Select	1 = Selects Command Register	0 = Selects prescale register			
			D <sub>14</sub>	Shape	1 = Current Shaping 0 = Shaping Off	21			
		7.76.7	1	Brake		92			
			D <sub>13</sub>	blake	1 = Brake (D <sub>8</sub> must be "0") 0 = Run	2			
			D <sub>13</sub>	Reg. Sat.	0 = Run 1 = Saturate External PNP	25			
	200			1 2 ts 1 1 1	0 = Run 1 = Saturate External PNP 0 = Regulate (only in unipolar mode) 0,1 = Alternating 1's and 0's advances				
	28 O 10 N		D <sub>12</sub>	Reg. Sat.	0 = Run 1 = Saturate External PNP 0 = Regulate (only in unipolar mode)	23			
	100 CM		D <sub>12</sub>	Reg. Sat.	0 = Run 1 = Saturate External PNP 0 = Regulate (only in unipolar mode) 0,1 = Alternating 1's and 0's advances commutation state only if D <sub>10</sub> = 1 1 = External Commutation	23			
	3870 (500)		D <sub>12</sub> D <sub>11</sub>	Reg. Sat.  Advance  Ext. Commutation	0 = Run  1 = Saturate External PNP  0 = Regulate (only in unipolar mode)  0,1 = Alternating 1's and 0's advances commutation state only if D <sub>10</sub> = 1  1 = External Commutation  0 = Internal BEMF Commutation  1 = Unipolar Mode	2 <sup>3</sup> 2 <sup>4</sup> 2 <sup>5</sup>			
	10 ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) (		D <sub>12</sub> D <sub>11</sub> D <sub>10</sub> D <sub>9</sub>	Reg. Sat.  Advance  Ext. Commutation  Unipolar/Bipolar*	0 = Run  1 = Saturate External PNP  0 = Regulate (only in unipolar mode)  0,1 = Alternating 1's and 0's advances commutation state only if D <sub>10</sub> = 1  1 = External Commutation  0 = Internal BEMF Commutation  1 = Unipolar Mode  0 = Bipolar Mode  1 = PWM Mode	2 <sup>5</sup> 2 <sup>6</sup>			
	0.000		D <sub>12</sub> D <sub>11</sub> D <sub>10</sub> D <sub>9</sub> D <sub>8</sub>	Reg. Sat.  Advance  Ext. Commutation  Unipolar/Bipolar *  PWM / Linear	0 = Run  1 = Saturate External PNP  0 = Regulate (only in unipolar mode)  0,1 = Alternating 1's and 0's advances commutation state only if D <sub>10</sub> = 1  1 = External Commutation  0 = Internal BEMF Commutation  1 = Unipolar Mode  0 = Bipolar Mode  1 = PWM Mode  0 = Linear Mode	2 <sup>5</sup> 2 <sup>6</sup>			
	84 0 ( CV)		D <sub>12</sub> D <sub>11</sub> D <sub>10</sub> D <sub>9</sub> D <sub>8</sub>	Reg. Sat.  Advance  Ext. Commutation  Unipolar/Bipolar *  PWM / Linear  Int. Test Mode	0 = Run  1 = Saturate External PNP  0 = Regulate (only in unipolar mode)  0,1 = Alternating 1's and 0's advances commutation state only if D <sub>10</sub> = 1  1 = External Commutation  0 = Internal BEMF Commutation  1 = Unipolar Mode  0 = Bipolar Mode  1 = PWM Mode  0 = Linear Mode  Must be set to '0' for normal operation  Don't Care	2 <sup>5</sup> 2 <sup>6</sup>			
	100 (CCC)		D <sub>12</sub> D <sub>11</sub> D <sub>10</sub> D <sub>9</sub> D <sub>8</sub>	Reg. Sat.  Advance  Ext. Commutation  Unipolar/Bipolar *  PWM / Linear  Int. Test Mode  N/A	0 = Run  1 = Saturate External PNP  0 = Regulate (only in unipolar mode)  0,1 = Alternating 1's and 0's advances commutation state only if D <sub>10</sub> = 1  1 = External Commutation  0 = Internal BEMF Commutation  1 = Unipolar Mode  0 = Bipolar Mode  1 = PWM Mode  0 = Linear Mode  Must be set to '0' for normal operation  Don't Care	2 <sup>5</sup> 2 <sup>6</sup>			



## HALL-LESS SPINDLE MOTOR DRIVER

Pin Name	PLCC Pin #	TQFP Pin #	Description
S <sub>CLOCK</sub>	9	6	A low to high transition clocks data into the serial port.
SLEW	10	7	A resistor between the slew pin and 5V supply establishes the maximum current to slew the gate of the N-channel FETs On/Off. Output Slew Current (mA) = k * ( $V_{DD} - V_{BE}$ ) / ( $R_{SLEW} + R_I$ ). Where: $R_{SLEW} \equiv$ External resistor connected to $V_{DD}$ ; $R_I \equiv$ Internal resistor, 2.5k < $R_I$ < 4.5k; $V_{BE} \equiv$ Base emitter voltage; k $\equiv$ Output current to slew current gain 1.5 < k < 2.2.
I <sub>A</sub> , I <sub>B</sub> , I <sub>C</sub>	17, 14 11	14, 11	Senses motor current to complete the transconductance loop. Relationship between motor current and $V_{CTRL}$ is given by; $I_{MOTOR} = (V_{CTRL} - V_{OFS})/G*R_s$ , and maximum motor current is calculated using $I_{MAX} = V_{CSMAX}/R_s$ , where; $G \equiv V_{CTRL}$ to Current Sense Gain, $R_s \equiv$ Sense Resistor, $V_{OFS} \equiv V_{CTRL}$ to $V_{C.S.}$ Offset
GROUND	12	9	
PWM T <sub>OFF</sub>	13	10	A resistor to 5V and capacitor to ground determines the fixed "off time" in PWM mode. $T_{OFF}\approx 0.7*R_{_T}*C_{_T}(T_{OFF(MIN.)}=5\mu sec)$
$S_A, S_B, S_C$	15, 22 19	12, 20 17	Comparators inputs used to sense BEMF.
$V_{\text{CTRL}}$	16	13	Voltage input that controls motor current.
$L_A$ , $L_B$ , $L_C$	18,21 24	16,19 22	Low side drivers for both linear and PWM control of external N-channel FET gates.
$H_{A'}$ $H_{B'}$ $H_{C}$	20,23 26	18,21 26	High side drivers enabled during bipolar drive that control the gates of external P-channel FETs
V <sub>cc</sub>	25	23	10.8 - 13.2V. Analog supply.
C <sub>T</sub>	27	27	Input pin that connects to the centertap of the spindle motor.
C <sub>T</sub> DRIVE	28	28	This pin must be left open.
		1,15 24,25	No connection internally.

## LX3191B

## HALL-LESS SPINDLE MOTOR DRIVER

#### PRELIMINARY DATA SHEET

# **GRAPH / CURVE INDEX** FIGURE INDEX **Characteristic Curves IC** Description FIGURE # FIGURE # 1. $V_{CTRL}$ OFFSET VOLTAGE vs. JUNCTION TEMPERATURE 9. MOTOR TORQUE WAVEFORM 2. CURRENT SENSE VOLTAGE vs. V<sub>CTRL</sub> 10. COMMUTATION TIMING DIAGRAM 3. BRAKE THRESHOLD VOLTAGE vs. JUNCTION TEMPERATURE 11. PROCESSOR TO VCTRI CONNECTION DIAGRAM 4. BRAKE DELAY TIME COEFFICIENT vs. JUNCTION TEMPERATURE 5. SLEW INPUT IMPEDANCE vs. SLEW CURRENT vs. TEMPERATURE 6. LOW SIDE LINEAR DRIVER SINK CURRENT vs. SLEW PIN CURRENT 7. HIGH SIDE DRIVER SINK CURRENT vs. TEMPERATURE 8. HIGH SIDE DRIVER SOURCE CURRENT vs. TEMPERATURE



## HALL-LESS SPINDLE MOTOR DRIVER

## PRELIMINARY DATA SHEET

#### CHARACTERISTIC CURVES

FIGURE 1. — V<sub>CTRL</sub> OFFSET VOLTAGE

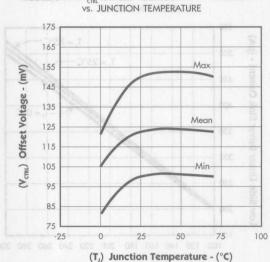


FIGURE 2. — CURRENT SENSE VOLTAGE VS. V

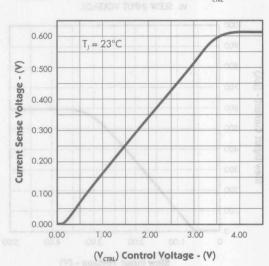


FIGURE 3. — BRAKE THRESHOLD VOLTAGE

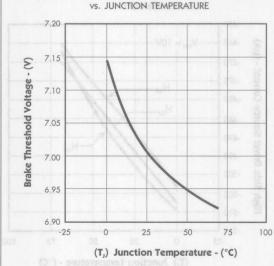
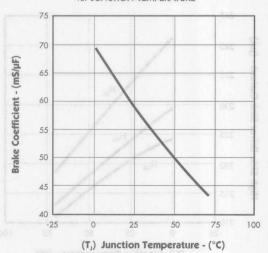


FIGURE 4. — BRAKE DELAY TIME COEFFICIENT Vs. JUNCTION TEMPERATURE



# LX3191B

#### HALL-LESS SPINDLE MOTOR DRIVER

#### PRELIMINARY DATA SHEET

#### CHARACTERISTIC CURVES

FIGURE 5. — SLEW INPUT CURRENT

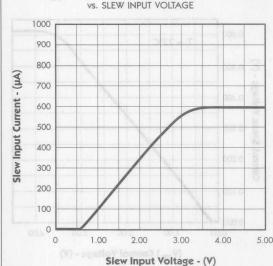


FIGURE 6. — LOW SIDE LINEAR DRIVER SINK CURRENT vs. SLEW PIN CURRENT

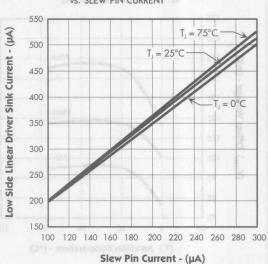


FIGURE 7. — HIGH SIDE DRIVER SINK CURRENT

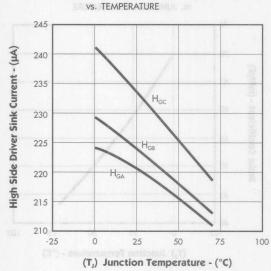
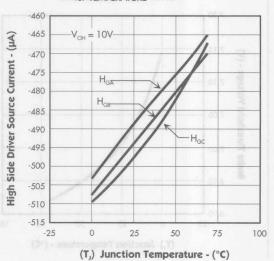


FIGURE 8. — HIGH SIDE DRIVER SOURCE CURRENT

vs. TEMPERATURE





#### HALL-LESS SPINDLE MOTOR DRIVER

#### PRELIMINARY DATA SHEET

#### **APPLICATION NOTES**

#### PRESCALE COUNTER

This part has digital commutation control driven by the master clock through the prescale counter. At normal motor operating speed, there should be exactly 128 cycles of the output from the prescale counter during each 1/6 of an electrical commutation cycle. If P is the number of motor poles then there are P/2 electrical commutation cycles per mechanical shaft revolution and the prescale counter output frequency is given by:

$$\frac{\text{mechanical RPM}}{60} * \frac{P}{2} * 6 * 128 = F_{\text{prescale}}$$

example: @5400 RPM, 8 pole motor:

$$F_{PRESCALE} = \frac{5400}{60} * 4 * 6 * 128 = 276.48 \text{ kHz}$$

The prescale counter consists of a fixed divide by 2 cascaded with a down counter which is repetitively loaded with the value N in the prescale register of the serial port and counted up to all 1's. Thus the total prescale frequency division from the master clock input is 2\* (N+1). Thus for the example above with a master clock of 10MHz:

$$2(N+1) = \frac{10*10^6}{276.48*10^3} \ , N+1=36.18, \Rightarrow N=17$$

Although at operating speed 7 bits are normally used, the actual size of the commutation counter is 10 bits, so the lowest speed that can be precisely internally commutated is  $1/2^3 = 1/8$  of the operating speed, unless the prescale counter is reprogrammed on the fly between startup and steady state run.

#### SERIAL INTERFACE INPUT

All logic level control inputs to the LX3191B are made through a three wire serial interface that may be clocked at rates up to 10MHz. Data is entered as two 16 bit words, most significant bit first and word select bit last (See Table 1 in Functional Pin Description Section).

One 16 bit word sets the division factor of the on chip prescale divider between the clock (pin5) and the internal commutation counters. As noted earlier, for proper operation of the current shaping as well as the commutation functions, the internal clock frequency should have 128 cycles during 60° electrical at steady state running speed. Therefore:  $F_{\text{INT CLOCK}} = 128 * \text{RPM/60} * \text{Poles/2} * 360/60$ , and prescale divisor, D = Chip Clock (pin5)/ $F_{\text{INT CLOCK}}$ The prescale counter is 8 stage binary with its least significant stage always enabled with a divisor of 2. The 16 bit is loaded per Table-1 in the Functional Pin Description Section. N = (D/2 - 1),

is entered as negatve true logic, i.e. logic low for binary ones. For example, if Chip Clock (pin5) = 10MHz (the maximum permitted frequency) and the motor has 8 poles running at 5400 RPM, then:

$$D = \frac{10 * 10^6}{128 * \frac{5400}{60} * \frac{8}{2} * \frac{360}{60}} = 36.196,$$

and N = (D/2 - 1) = (36/2 - 1) = 17. Thus the prescale word would be sent to the serial port as negative true with MSB loaded first.

 $D_8 \rightarrow D_{14}$  represents 17 as negative true word.  $D_{15}$  is the word select bit = 0 for selecting pre-scale.  $D_0 \rightarrow D_7 = 0$ 

The other serial port word (command) contains seven control bits as shown in Table 1, under the Functional Pin Description

#### COMMUTATION

Perhaps the most essential function in a sensorless, brushless motor controller is commutation. The requirements are better understood by referring to Figure 9.

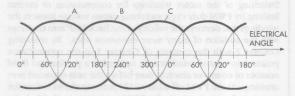


FIGURE 9 — MOTOR TORQUE WAVEFORM

The fundamental principle of Back EMF sensorless commutation is that one of the three windings always has zero current when its voltage, generated with respect to the neutral, passes through zero. Thus by placing comparators from each of the phase voltages with respect to neutral, logic signal edges are obtained at 0°, 60°, 120°, and 180° electrical degrees. Also note that switching signals for commutation are required at 30°, 90°, 150°, and 210°, or halfway between the phase voltage zero crossings. Obtaining the commutation signals from the zero crossings in the LX3191B is done with two counters as shown in Figure 10 on the next page.

#### HALL-LESS SPINDLE MOTOR DRIVER

#### PRELIMINARY DATA SHEET



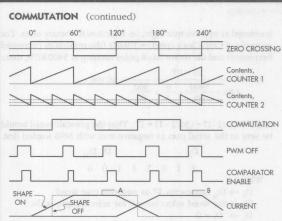


FIGURE 10 — COMMUTATION TIMING DIAGRAM

Counter #1 is reset at the zero crossings and counts up. Counter #2 is loaded with ½ the contents of Counter #1 just before it is reset; when it counts down to zero the commutation point is defined as ½ the time between the previous two crossings, independent of the actual time which is dependent on motor speed.

#### **PWM START UP**

Switching of the motor windings for commutation or current limiting by PWM duty cycle switching causes voltage noise in the windings that destroys the validity of the Back EMF zero crossings with the addition of many more erroneous ones. By reloading Counter 2 with the contents of Counter 1 at the commutation points, two control windows are opened at a precise and fixed number of counts or absolute time before the next expected zero crossing. At the PWM off window (20 prescale clocks before the anticipated zero crossing), the PWM modulator is disabled, the system returns to linear mode of operation, to stop its switching noise. After 14 clock cycles the zero crossing window opens and comparator outpus are gated on to look for the next true zero crossing. By use of digital counters rather than analog integrators for these functions, the window accuracy can be held so tight that pwm current limiting becomes practical without adverse effects on commutation accuracy.

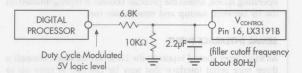
It is important to allow enough time for the system's current loop to settle when the PWM to linear switch over occurs. Failure to do this allows the wrong BEMF comparator to commutate the state due to the motor inductance ringing and coupling that may continue well into the time that the window opens. To avoid this, the prescale counter is loaded with a larger number to redue the internal clock and allow for more timing. This can be done several times as the motor is gaining velocity during the start up.

#### **CURRENT WAVE SHAPING**

The contents of counter 1 also drives a multiplying D to A whose analog reference input is the control voltage for setting the motor current for speed control. By using the true and complement outputs of the D to A, trapezoidal waveform current references are obtained for the phase currents while maintaining the cross over point accurately at the true commutation point regardless of current magnitude. This is not possible with current profiling methods that fix the current slew rate to obtain "soft switching." By shifting the current gradually between windings, the point of application of the reaction torque to the motor stator windings also moves gradually rather than abruptly, greatly reducing acoustic noise.

#### MOTOR CURRENT SETTING

The motor current is set by the relationship:  $I_{\text{MOTOR}} = V_{\text{CTRL}}/G * R_s$ , where  $R_s$  is the resistor value connected between each of pins 18, 21, 24, the corresponding NMOS power transistor sources and ground.  $V_{\text{CTRL}}$  is the voltage provided on pin 16. The maximum C.S. voltage for  $V_{\text{CTRL}}$  of 3.2V is a minimum of 0.48V. So the maximum motor current for an  $R_s$  of 0.33 $\Omega$  would be at least 1.45 amps. The control voltage is a digital filter implementation of the speed control algorithm. Since speed control bandwidths are usually 5Hz or less, digital to analog conversion of  $V_{\text{CTRL}}$  is easily accomplished by a pulse width modulated logic level output from the processor and a first order ripple filter as described in Figure 11.



 $\textbf{FIGURE 11} \ - \ \texttt{PROCESSOR TO} \ \texttt{V}_{\texttt{CTRL}} \ \texttt{CONNECTION DIAGRAM}$ 

An offset is built into the  $V_{\rm CTRL}$  pin that allows zero current when the processor's duty cycle is set at zero.

#### HALL-LESS SPINDLE MOTOR DRIVER

#### PRELIMINARY DATA SHEET

#### APPLICATION NOTES (continued)

#### **VELOCITY FEEDBACK**

The logic level output signal provided on pin 6 of the LX3191B is the zero crossing signal shown in Figure 10. It has a frequency of 3 \* (number of poles /2) cycles per mechanical motor revolution. Thus to get a once per revolution speed signal with an 8 pole motor, the frequency of pin 6 ( $F_{\rm COM}$ ) would be divided by 12 in the speed control processor.

#### **BACK EMF COMPARATORS**

The inputs of the Back EMF sensing comparators are differential from input pins 15, 22, and 19 with respect to the neutral at pin 27. There are back to back clamping diodes on the comparator inputs and it is recommended that RC networks as shown in the application figure be used between the motor phase terminals and the comparator inputs. These filters are not part of the commutation algorithm but rather are for limiting the slew rate of the inductive motor switching noise, especially during PWM operation. The comparator inputs are bipolar, so typ resistors in the range of 10 to  $20 {\rm K}\Omega$  or smaller should be used in order to minimize the effects of the input bias currents. To avoid timing errors in commutation, the RC time constant should be on the order of  $2.5^\circ$  electrical at run or RC =  $60/{\rm RPM}*2/{\rm Poles}*2.5/360$ . At 5400 RPM and 8 poles this is about 20µs or  $10 {\rm K}\Omega$  and  $2200 {\rm pF}$ .

#### LOW SIDE DRIVERS

Each of three low side drivers is really three in parallel: a current mode linear driver, a fast switching, high current to tempole type voltage mode driver for PWM use, and a PMOS switch for connecting the output to the brake capacitor for brake operation. The linear driver provides symmetrical source and sink current of 1.8 \* (V $_{\rm DD}$  - 0.65 V) / (R $_{\rm SLEW}$  + 3.8 K $\Omega$ ) where R $_{\rm SLEW}$  is a resistor connected from pin 10 to the 5 volt supply. A reasonable value of current is about 200µA which requires a R $_{\rm SLEW}$  resistor of: 1.8 \* 4.35 /0.2 \* 10 $^3$  = R $_{\rm SLEW}$  + 3.8 \* 10 $^3$ , R $_{\rm SLEW}$  = 36 K $\Omega$ .

The voltage mode driver used in PWM mode has high current capabilities of ±20mA for fast switching of the NMOS power transistor gate capacitance.

#### HIGH SIDE DRIVERS

The positive supply for the high side drivers is the retract line which is the source of the external P-MOS power transistors. During retract there is a constant current of about 500µA and the turn off gate current is about 250µA. This assures a relatively fast switching speed which is still slew limited by the external gate and miller capacitance of the power P-MOS transistors.

#### **BRAKE FUNCTION**

The brake function capacitor used on pin-3 of the LX3191 serves two purposes: 1). To provide a time delay after loss of supplies as indicated by the power good signal on pin 2 until the brake is applied. This allows the heads to be positioned to the landing zone. 2). To provide a source of voltage with the supplies gone for turning on all three of the NMOS power transistors for dynamic braking. When the supplies are present the capacitor is charged to the 12 volt supply. When power good goes false it is discharged by an internal nominal current to a level of about 7 volts, where the current drops to a very small value and the capacitor voltage is applied to the NMOS gate lines by internal PMOS transistors, providing a much longer time for dynamic braking.

In our previous example, a  $15\mu F$  capacitor provides a nominal delay timer ( $15\mu F*60ms/\mu F=900ms$ ) and a typical brake time of about 19 sec.

#### PWM OFF-TIME CONTROL

The PWM current limit circuit works as a constant off time configuration. The off time is set by a resistor from pin 13 to the +5 supply of 10K typical and a capacitor from pin 13 to ground. The off time is 0.69 RC and maximum recommended frequency is 100KHz. So for an off time of 10µsecond:

 $0.69 * 10^4 * C = 10 * 10^{-6} \Rightarrow C = 14.5 * 10^{-10}F \approx 1500pF$ 



#### PRILIMINARY BATA SHEET

#### VELCICIEV PERDIACIO.

The logic level output signal provided on pin 6 of the EXEMP. If his a frequency is the zero crossing signal shows to Figure 10. If his a frequency of 3 - (minher of poles 2) tycles per medianical meter revolution. Thus to get a once per revolution speed signal with as 8 pole motor, the frequency of pin 6 (from) would be divided by 12 in the speed control processor.

#### BACK DWF COMPARATORS

#### ESSYLVE BOTH WOR

Each of three low side drivers is really flave in parallels a current mode linear driver, a last switching, high current foreign type voltage mode driver for PSFM use, and a PMOS switch for connecting the output to the brake exploiter for higher operation. The linear driver provides symmetrical source and ank current of line  $1.8 \times V_{\rm top} \sim 0.65 \text{VJ} / (R_{\rm atra} + 3.8 \text{CO})$  where  $R_{\rm atra}$  is a resistor connected from pin 10 to the 5 volt supply A reasonable value of current is about 300pA which requires a  $R_{\rm atra}$  resistor of  $1.8 \times 4.35 \text{Vd} \approx 2.014 \text{ R}_{\odot} = 3.013 \text{ R}_{\odot} = 3$ 

The voltage mode driver used in PWM mode has light current capabilities of ±20mA for fast switching of the RMOS power translator gate capacitance.

#### HIGH SIDE DAYSERS

The positive supply for the high side drivers is the retract line which is the source of the external P-MOS power transistors. Paring crivet there is a constant current of about 500µA and the form off gate current is always 250µA. This assures a relatively fast switching sprend which is said slew limited by the external gate and miller capacitance of the power P-MOS transistors.

#### HORDING THAT

The brake function capacitor used on pin-3 of the LX3191 serves two purposes: D. To provide a time delay after loss of supplies two purposes: This allows the power good signal on pin 2 until the traite is applied. This allows the treats to be positioned to the landing applied. This allows the treats to be positioned to the landing for mining on all these of the MMOS power translators for dynamic for mining on all these of the MMOS power translators for dynamic to the TZ with simply. When power good goes false it is disappred by an internal nominal comess to a level of about 7 wolls, where the concent dops to a very small value and the capacitors wollage is applied to the MMOS gate lines by internal PMOS translators, providing a much longer time for dynamic leading.

In our previous example, a 15pF capacitor provides a nominal lelay timer (15pF - 66ms/pF - 906ms) and a typical brake time of about 19 sec.

#### PWW OFFTIME CONTROL

The PWM correin limit circuit works as a constant off time configuration. The off time is set by a resistor from pin 13 to the example of 10K typical and a capacitar from pin 12 to ground. The off time is 0,09 fiC and maximum recommended frequency is 100KHz. So for an off time of thyseconds.

0.60 · 10 · C + 10 · 10 = C = 14.5 · 10 F = 1500ml



# SG1635/SG3635

#### 2A HALF BRIDGE DRIVER

THE INFINITE POWER OF INNOVATION

NOT RECOMMENDED FOR NEW DESIGNS

#### DESCRIPTION

The SG1635 is a monolithic integrated circuit designed to interface low-level logic signals with high-current, inductive, or capacitive loads. This device is particularly adept at high-speed pulse width modulation for motor drives or Class D audio amplifiers, and when used in pairs, they can provide full bridge drive for bi-directional control.

With TTL-compatible units, this device will either source or sink up to 5A of peak current with interlock protection to insure that source and sink cannot be on simultaneously. Additional protection is provided by thermal shutdown of the source output if the chip temperature rises above 160°C. High speed internal commutating diodes are also included.

#### KEY FEATURES

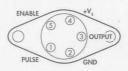
- SOURCE OR SINK 5A PEAK
- HALF-BRIDGE WITH INTERNAL DIODES
- TTL INPUT COMPATIBILITY
- EITHER DUAL OR TRI-STATE OUTPUT
- DIRECT PWM MOTOR DRIVE FROM MICROPROCESSOR
- BUILT-IN THERMAL PROTECTION
- SG3635P REPLACES UDN2935Z

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

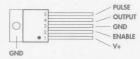
#### PACKAGE PIN OUTS



CASE IS GROUND

Case & Tab are internally connected to substrate ground

R PACKAGE (Top View)



Case & Tab are internally connected P PACKAGE

(Top View)

PACKA	GE ORDER INF	ORMATION
T <sub>A</sub> (°C)	R Metal Can TO-66 5-pin	Plastic TO-220 5-pin
0 to 70	SG3635R	SG3635P
-55 to 125	SG1635R	_
MIL-STD-883	SG1635R/883B	<del>-</del>

# Notes

for Recommended for Mew Designs

- IN SOURCE OR SHIK SA REAK
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First (Tr.) compatible units, this device will either source or sick up to SA of peak correst with interiors, proceeding to instance that secure and sink corner be on simultaneously. Additional protection is provided by thermal shuldown of the source output

communicación diodes are also include

The \$6.7635 is a monolithic integrated circuit designed to interface low-level logic signals with high-current inductive, or capacitive londs. This device is particularly adopt at high speed pulse width modulation for motor drives or Class D audio amplifiers, and when used in pars, bey can provide full bridge drives for boy can provide full bridge drives for

COMPLETE SPECIFICATIONS EVALUABLE TROM "LIM" FAX SYSTEM
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# SG1731/SG2731/SG3731

DC MOTOR PULSE WIDTH MODULATOR

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

The SG1731 is a pulse width modulator circuit designed specifically for DC motor control. It provides a bidirectional pulse train output in response to the magnitude and polarity of an analog error signal input. The device is useful as the control element in motor-driven servo systems for precision positioning and speed control, as well as in audio modulators and amplifiers using carrier frequencies to 350kHz.

The circuit contains a triangle waveform oscillator, a wideband

operational amplifier for error voltage generation, a summing/scaling network for level-shifting the triangle waveform, externally programmable PWM comparators and dual ±100mA, ±22V totem pole drivers with commutation diodes for full bridge output. A SHUTDOWN terminal forces the drivers into a floating high-impedance state when drive LOW. Supply voltage to the control circuitry and to the output drivers may be from either dual positive and negative supplies, or single-ended.

#### KEY FEATURES

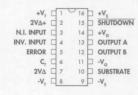
- ±3.5V TO ±15V CONTROL SUPPLY
- ±2.5V TO ±22V DRIVER SUPPLY
- DUAL 100mA SOURCE/SINK OUTPUT DRIVERS
- 5kHz TO 35kHz OSCILLATOR RANGE
- HIGH SLEW RATE ERROR AMPLIFIER
- ADJUSTABLE DEADBAND OPERATION
- DIGITAL SHUTDOWN INPUT

#### HIGH RELIABILITY FEATURES

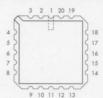
- AVAILABLE TO MIL-STD-883B
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

# PACKAGE PIN OUTS



J & N PACKAGE (Top View)



3. 2V<sub>a</sub>,
4. N.I. INPUT
5. INV. INPUT
6. N.C.
7. ERROR
8. C<sub>T</sub>
9. 2V<sub>a</sub>
10. -V<sub>T</sub>

1. N.C.

2. V<sub>T+</sub>

12. -V<sub>5</sub>
13. SUBSTRATE
14. -V<sub>0</sub>
15. OUTPUT B
16. N.C.
17. OUTPUT A
18. +V<sub>0</sub>
19. SHUTDOWN
20. +V<sub>5</sub>

11. N.C.

L PACKAGE (Top View)

PACKAGE ORDER INFORMATION					
T <sub>A</sub> (°C)	L Ceramic LCC 20-pin				
0 to 70	SG3731N	SG3731J	_		
-25 to 85	SG2731N	SG2731J	_		
-55 to 125		SG1731J			
MIL-STD-883	<del>-</del>	SG1731J/883B	SG1731L/883B		

# Notes

PRODUCTION DATA SHELT

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#### RICH PERIABILITY FEATURES

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permonal suplifier for error voltage generation, a summing service generation, a summing service generation, in level shifting the tracegle waveform, action supported to the service of deal actions. a 22% care pole divisor with communition fields for full before entire. A little own from the first poly terminal forces the other state when three LOW. Supply voltage to the control circums and to the output fields may be tropic entered and posterior state.

The SG1731 is a pulse with modulator circuit designed specifically for BC motor control. It provides a bi-directional pulse train output in response to the respituale and polarity of an analog error signal input. The device is useful as the control element in motor-drevu newo systems for precision postuoning and spord, as well as in audio modulators and amplifiers using carrier frequencies to \$50kHz.

The circuit contains a mangle wavelong oscillator, a widehood

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#### POWER OPERATIONAL AMPLIFIER

THE INFINITE POWER OF INNOVATION PRODUCTION DATA SHEET

#### DESCRIPTION

The SG2273/3273 is a monolithic power operational amplifier, which features a high-current, low-saturation voltage, flyback protected output stage optimized for driving heavily inductive loads. Capable of operation in a single supply mode from as low as 4.5V up to 13.2V, the SG2273/3273 is ideally suited for the computer peripheral environment, driving small motors, solenoids, and linear actuators in an H-bridge configuration.

As a general-purpose op amp, the

SG2273/3273 exhibits low input offset voltage, high open loop gain, low quiescent current, a large differential input voltage range, and a commonmode input voltage range, which includes ground  $(V_{FF})$ .

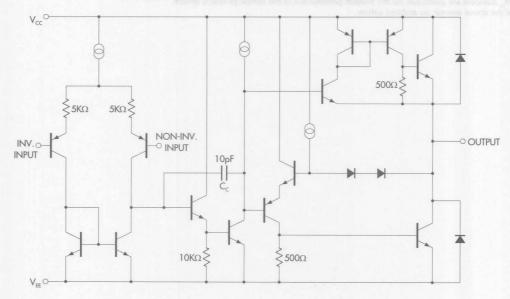
Available in a 5-pin TO-220 package, the SG2273/3273 provides system designers with a low-cost, convenient way to minimize power dissipation and reduce board area consumption in applications requiring high-current inductive load capability.

#### KEY FEATURES

- FULL OUTPUT SWING AT ±1A
- HIGH INDUCTIVE LOAD DRIVE CAPABILITY
- INTERNAL FLYBACK PROTECTION DIODES
- LOW POWER DISSIPATION
- SINGLE OR SPLIT SUPPLY OPERATION
- COMMON-MODE RANGE INCLUDES GROUND (V<sub>FE</sub>)
- HIGH OPEN LOOP GAIN
- LOW INPUT OFFSET VOLTAGE
- LARGE DIFFERENTIAL INPUT VOLTAGE **RANGE**
- THERMAL SHUTDOWN PROTECTION

#### PRODUCT HIGHLIGHT

#### SG2273 CIRCUIT SCHEMATIC DIAGRAM



#### PACKAGE ORDER INFO

T <sub>A</sub> (°C)	Plastic TO-220 5-pin
0 to 70	SG3273P
-45 to 85	SG2273P

FOR FURTHER INFORMATION CALL (714) 898-8121

#### Power Operational Amplifier

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Note 1. Values beyond which damage may occur. All voltages are specified with respect to ground, and all currents are positive into the specified terminal.

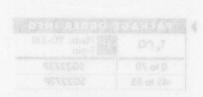
# PACKAGE PIN OUTS V<sub>cc</sub> OUTPUT V<sub>gc</sub> (Gnd) INV INPUT NON-INV INPUT P PACKAGE (Top View)

#### THERMAL DATA

#### P PACKAGE:

THERMAL RESISTANCE-JUNCTION TO CASE, $\theta_{\rm JC}$	4.0°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, $\theta_{_{J_{\Delta}}}$	55°C/W

Junction Temperature Calculation:  $T_J = T_A + (P_D \times \theta_{JA})$ . The  $\theta_{JA}$  numbers are guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.





70

°C

#### POWER OPERATIONAL AMPLIFIER

#### PRODUCTION DATA SHEET

#### RECOMMENDED OPERATING CONDITIONS (Note 2) **Recommended Operating Conditions** Parameter Symbol Units Тур. Supply Voltage (Single Supply) 4.5 ±1.2 DC Output Current 0 V -- 2 Common-Mode Input Voltage Differential-Mode Input Voltage ±V<sub>cc</sub> Operating Ambient Temperature Range: SG2273 -40 85 °C TA

Note 2. Range over which the device is guaranteed functional.

#### ELECTRICAL CHARACTERISTICS

TA

0

(Unless otherwise specified, these specifications apply over the operating ambient temperatures of  $-40^{\circ}\text{C} \le T_{A} \le 85^{\circ}\text{C}$  for the SG2373 and  $0^{\circ}\text{C} \le T_{A} \le 70^{\circ}\text{C}$  for the SG3273;  $V_{cc}$ =12V. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions		G227	3	!	G327	3	Units
Farameter	Symbol	lest collaitions	Min.	Тур.	Max.	Min.	Тур.	Max.	Oilit
Static Characteristics									
Input Offset Voltage	V <sub>IO</sub>	T <sub>A</sub> = 25°C	-15	0	15	-15	0	15	mV
			-40		40	-30	112	30	mV
Input Bias Current	I <sub>B</sub>	T <sub>A</sub> = 25°C	-1.0	-0.2		-1.0	-0.2		μΑ
Input Offset Current	los	T <sub>A</sub> = 25°C	-50		50	-50		50	nA
			-200		200	-200		200	nA
Differential Input Resistance	R <sub>ID</sub>		500			500			ΚΩ
Source Side Output Saturation Voltage	+V <sub>SAT</sub>	I <sub>OUT</sub> = 100mA		0.8	1.0		0.8		٧
		I <sub>out</sub> = 500mA		1.0	1.5		1.0	1.5	٧
		I <sub>OUT</sub> = 1A		1.4	2.0		1.4	2.0	٧
Sink Side Output Saturation Voltage	-V <sub>SAT</sub>	I <sub>OUT</sub> = 100mA		0.3	0.7		0.3		٧
		I <sub>OUT</sub> = 500mA		0.6	1.0		0.6	1.0	٧
		I <sub>OUT</sub> = 1A		1.3	2.0		1.3	2.0	٧
Open Loop Voltage Gain	A <sub>VOL</sub>		70	90		70	90		dB
Common-Mode Rejection Ratio	CMRR	T <sub>A</sub> = 25°C	66	90		66	90		dB
Power Supply Rejection Ratio	PSRR		60	80		60	80		dB
Quiescent Drain Current	Icc	T <sub>A</sub> = 25°C		7	17		7	15	mA
Thermal Shutdown Temperature		T <sub>A</sub> = 25°C		175			175		°C
Dynamic Characteristics ( $T_A = 25^{\circ}$ C	()								
Gain Bandwidth Product	GBWP	$RL = \infty \Omega$		800			800		KHz
Slew Rate	dVo/dt	AV = 1		1.6			1.6		V/µs
Power Bandwidth, -3dB	PBW			200			200		KHz
Input Noise Voltage	E <sub>N</sub>	22Hz to 22KHz		10			10		μV
Input Noise Current	I <sub>N</sub>	22Hz to 22KHz		200			200		рА
Channel Separation	CS	$f = 1KHz$ , $R_1 = 10\Omega$ , $AV_{c1} = 30dB$		60			60		dB

GRAPH / CURVE INDEX

#### POWER OPERATIONAL AMPLIFIER

#### PRODUCTION DATA SHEET

FIGURE INDEX

# **Application Circuits Characteristic Curves** 9. INVERTING POWER AMPLIFIER 1. LARGE SIGNAL TRANSIENT RESPONSE 2. SMALL SIGNAL TRANSIENT RESPONSE 10. NON-INVERTING POWER AMPLIFIER 3. COMMON-MODE REJECTION RATIO vs. FREQUENCY 11. REGULATED CURRENT SOURCE FOR A GROUNDED LOAD 12. ADJUSTABLE TEMPERATURE CONTROL 4. POWER SUPPLY REJECTION vs. FREQUENCY 5. OPEN LOOP GAIN vs. FREQUENCY 13. 3.5-INCH WINCHESTER DISK DRIVE HEAD POSITION CONTROL 6. SUPPLY CURRENT vs. SUPPLY VOLTAGE 7. SUPPLY CURRENT vs. TEMPERATURE 8. SATURATION VOLTAGE vs. LOAD CURRENT



#### Power Operational Amplifier

#### PRODUCTION DATA SHEET

#### CHARACTERISTIC CURVES

FIGURE 1. — LARGE SIGNAL TRANSIENT RESPONSE

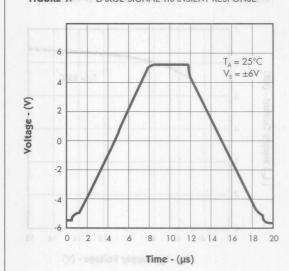


FIGURE 2. — SMALL SIGNAL TRANSIENT RESPONSE

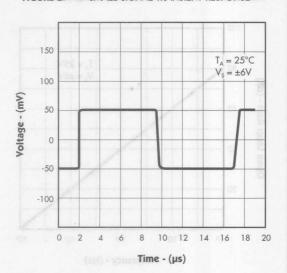


FIGURE 3. — COMMON-MODE REJECTION RATIO vs. FREQUENCY

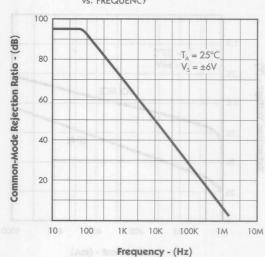
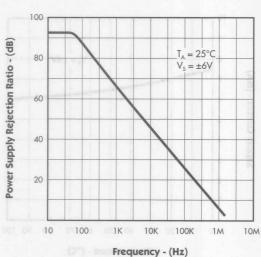


FIGURE 4. — POWER SUPPLY REJECTION vs. FREQUENCY



#### Power Operational Amplifier

#### PRODUCTION DATA SHEET

#### CHARACTERISTIC CURVES

FIGURE 5. — OPEN LOOP GAIN VS. FREQUENCY

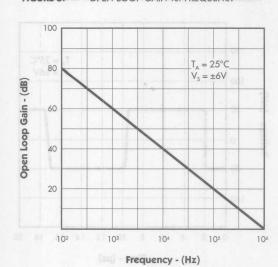
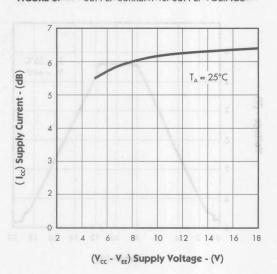


FIGURE 6. — SUPPLY CURRENT vs. SUPPLY VOLTAGE



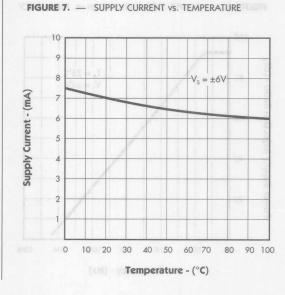
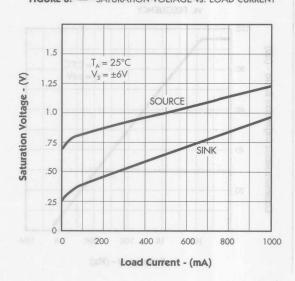


FIGURE 8. — SATURATION VOLTAGE vs. LOAD CURRENT





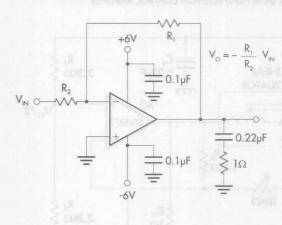
#### POWER OPERATIONAL AMPLIFIER

#### PRODUCTION DATA SHEET

#### TYPICAL APPLICATION CIRCUITS

FIGURE 9. — INVERTING POWER AMPLIFIER

FIGURE 10. — NON-INVERTING POWER AMPLIFIER



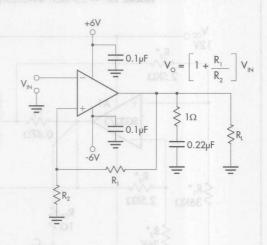
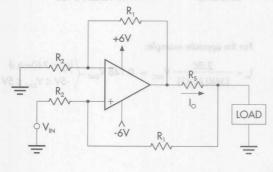
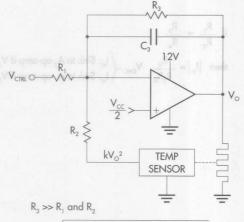


FIGURE 11. — REGULATED CURRENT SOURCE FOR A GROUNDED LOAD

FIGURE 12. — ADJUSTABLE TEMPERATURE CONTROL





 $R_{\rm S} << R_{\rm 1}$  and  $R_{\rm 2}$ 

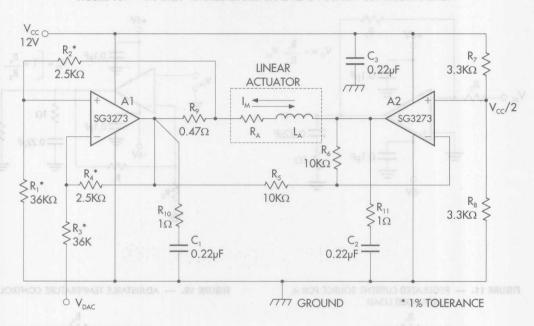
$$V_{o} = \sqrt{\frac{1}{k} \left[ \frac{V_{CC}}{2} \left( 1 + \frac{R_{1}}{R_{2}} \right) - \frac{R_{2}}{R_{1}} V_{CTRL} \right]}$$

#### Power Operational Amplifier

#### PRODUCTION DATA SHEET

#### TYPICAL APPLICATION CIRCUITS

FIGURE 13. — 3.5-INCH WINCHESTER DISK DRIVE HEAD POSITION CONTROL AMPLIFIER



if 
$$\frac{R_1}{R_2} = \frac{R_3}{R_4}$$

then 
$$\left|I_{M}\right| = \frac{R_{4}}{R_{3}R_{A}}$$
  $V_{DAC} = \sqrt{I_{M}}$ : Sink to  $A_{2}$  op-amp if  $V_{DAC} < 0$   $I_{M}$ : Sink to  $A_{1}$  op-amp if  $V_{DAC} > 0$ 

For the opposite example:

$$I_{M} = \frac{2.5K}{(36K)(0.47)} V_{DAC} = 0.148 V_{DAC} - \begin{cases} I_{M} \le 740mA \text{ if } -5V \le V_{DAC} \le 5V \end{cases}$$







#### DUAL-POWER OPERATIONAL AMPLIFIER

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

#### DESCRIPTION

The SG3272 is a monolithic dual-power operational amplifier which features a high current, low saturation voltage, flyback protected output stage optimized for driving heavy inductive loads. Capable of operation in a single supply mode from as low as 4.5V up to 13.2V, the SG3272 is ideally suited for the computer peripheral environment, driving small motors, solenoids, and linear actuators in an H-bridge configuration.

As a general-purpose op-amp, the SG3272 exhibits low input offset

voltage, high open loop gain, low quiescent current, a loarge differential input voltage range, and a common-mode input voltage range which includes ground ( $V_{\rm FF}$ ).

Available in either an 8-pin plastic dip package or a wide-body 20-pin SOIC Power, the SG3272 provides system designers with a low-cost, convenient way to minize power dissipation and reduce board area comsumption in applications requiring high current inductive load drive capability.

#### KEY FEATURES

- FULL OUTPUT SWING AT ±500mA
- HIGH INDUCTIVE LOAD DRIVE CAPABILITY
- INTERNAL FLYBACK PROTECTION DIODES
- LOW POWER DISSIPATION
- SINGLE OR SPLIT SUPPLY OPERATION
- COMMON-MODE RANGE INCLUDES GROUND (V<sub>EE</sub>)
- HIGH OPEN LOOP GAIN
- LOW INPUT OFFSET VOLTAGE
- LARGE DIFFERENTIAL INPUT VOLTAGE RANGE
- THERMAL SHUTDOWN PROTECTION

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### PACKAGE PIN OUTS INV. INPUT A OUTPUT A NON-INV. INPUT A OUTPUT B 6 NON-INV. INPUT B VEE (GND) 5 INV. INPUT B Y PACKAGE (Top View) 20 DOUTPUT A OUTPUT B 19 I N.C. N.C. □ N.C. V<sub>FF</sub> (GND) 17 V<sub>EE</sub> (GND) VE (GND) 16 VE (GND) Heatsink VEE (GND) □ V<sub>FF</sub> (GND) VEE (GND) 14 VE (GND) N.C. 13 N.C. INV. INPUT B INV. INPUT A NON-INV. INPUT B 11 \_\_\_ NON-INV. INPUT A DWP PACKAGE (Top View)

# | TA (°C) | M | Ceramic DIP | DWP | Plastic SOWB | Power, 16-pin | O to 70 | SG3272M | SG3272DWP

Note: All surface-mount packages are available in Tape & Reel. Append the letter "T" to part number. (i.e. SG3272DWPT)

FOR FURTHER INFORMATION CALL (714) 898-8121

# Notes

PRODUCTION DATA SHITT

IN RUEL OUTFUS SWIFTS AT #500mA.

voltage, high upon toop data, low quies contract, a loange differential input vellage range, and a common-mode input voltage range structured includes ground eV<sub>11</sub>2.

Available in either an e-pin picket.

Available of a self-body 24-pin SCIC Force, the SQ 27 2 practice system adequate with a four-cost, considered way to minise proves designated and reduce beautiful

cobsulption in apple atoms required high entreis inductive load drive The \$65272 is a improvide dual-power bight carrier leadings are high carriers low saturation voltage, by accorded output stage. Byback proceeded output stage optimized for drying heavy inductive loads. Capable of operation in a single supply mode from as low as 4.5% up to 15.2%, the \$63.772 is ideally societ for the computer perpheral enginement, five mail motors, solenoids, and driving small motors, solenoids, and ideas actuators in an 14-bridge.

As a general-purpose op-amp, the \$63272 exhibits low input offset

COMPLETE SPECIFICATIONS AVAILABLE FROM "ENIX" FAX SYSTEM

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TAPE SCHOOL TO SCHOOL SCH





SG3645

QUAD 2.5 AMP POWER DRIVER

THE INFINITE POWER OF INNOVATION

NOT RECOMMENDED FOR NEW DESIGNS / LIFETIME BUY

#### DESCRIPTION

The SG3645 is a quad high voltage, high current driver ideal for driving stepper motors. Each channel consists of TTL compatible inputs and open collector-Darlington outputs with integral transient suppression diodes. A common enable is provided to diable or enable all four outputs simultaneously. The output stages are

capable of sinking 2.5 Amps with breakdown voltage in excess of 60 volts. Thermal shutdown is provided to disable the outputs if excessive die heating occurs. The SG3645 is specified for operation over the ambient temperature range of 0°C to 125°C and is available in the thermally efficient plastic Batwing package.

#### KEY FEATURES

- PEAK OUTPUT CURRENTS TO 3.5A
- OUTPUT VOLTAGES TO 60V
- INTEGRAL CLAMP DIODES
- COMMON ENABLE PIN
- TTL COMPATIBLE INPUTS
- THERMAL SHUTDOWN PROTECTION

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### PACKAGE PIN OUTS OUT 1 ENABLE -DIODE COMMON 15 IN 2 OUT 2 14 13 EMITTER / SUBSTRATE EMITTER / SUBSTRATE OUT 3 IN 3 IN 4 OUT 4 10 LOGIC GND W PACKAGE (Top View)



# Notes

or Recommended for Bestons / Likering Buy

HE INFINITE POWER OF INCOMETON

ARE OF STREET CURRENTS TO 3.5A

B. QUIRUT VOUTAGES TO (GV

MIS STRANG BOARDS PIR

ETHERNESIS TABLETS

MOTDETONS MAYOUT HE HOASTHE IN

equite of sudoing 2.5 Amps with breakdown voltage in excess of 60 volts. Thermal shutchown is provided to disable the output if excessive distingt occurs. The idigioish is specified for operation were the specified for operation were the

righ current driver ideal for driving support on the part moving. Bach channel consider at TEL compact believes and open collector Darlington outpits with niegosi transfert suppression diolics.

Common enable is provided to diable.

COMPLET INSTRUCTIONS WAILARD INON "LIN" FAX SYSTEM
154 PM 4-1) AND 1990/91 SUCON GENERAL DATADOOK



7, (\*\*) \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200 | \$1, 200



Introduction

Quality

**Working With Linfinity** 

**Linfinity Information Network** 

Part Number Selection / Info

**Power Supply Circuits** 

**Data Communication Circuits** 

**Signal Conditioning Circuits** 

**Motion Control Circuits** 

**Other Linear Circuits** 

**Military Products** 

**Discontinued Products** 

**Package Information** 

Representatives / Distributors

10

# Notes



# **Section Index**

#### OTHER LINEAR CIRCUITS

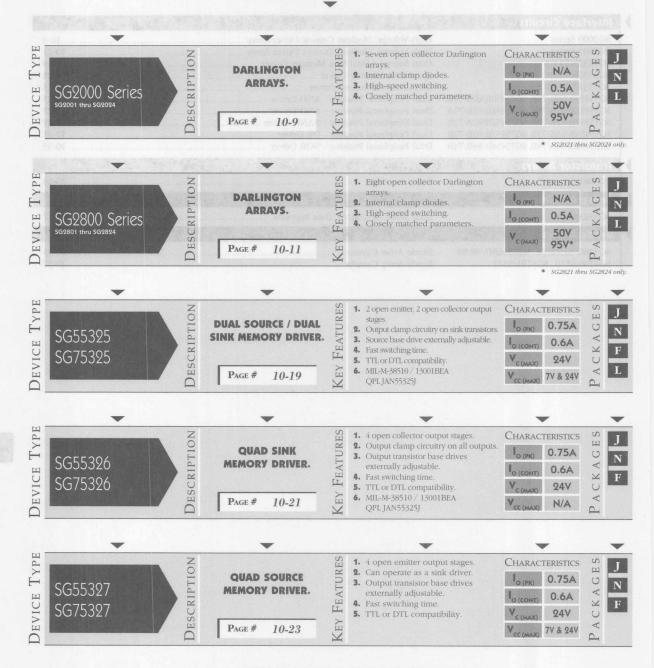
	Interface Circuits		
	SG2000 Series	High-Voltage, Medium Current Driver Array	10-9
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	Transistor Arrays	校理 英語 對 多数 医动物 医动物 医动物 医多种	NEW THE RE
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**Bold** = New Product, \*Bold Italic = Preliminary



#### OTHER LINEAR CIRCUITS

Interface Circuits



#### OTHER LINEAR CIRCUITS

Interface Circuits

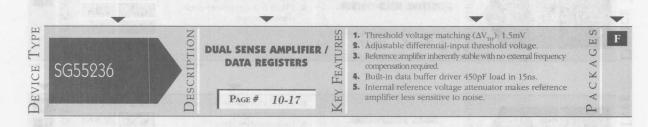
DESCRIPTION 1. Two NAND gates and two CHARACTERISTICS uncommitted NPN transistors. **DUAL PERIPHERAL** 0.4A 9 SG55450B/75450B 2. High-speed switching. POSITIVE AND DRIVER. A 3. TTL or DTL compatible diode-EVICE SG55460/75460 0.3A FE, clamped inputs. X U 4. Can be configured as an AND gate SG55470/75470 (common emitter configuration) or as a A PAGE # 10-25 NAND gate (emitter follower configuration) \*\* SG55450B = 35V. SG55460 = 40V. and SG55470 = 70V TYPE DESCRIPTION FEATURES 1. Two AND gates with open CHARACTERISTICS collector outputs. **DUAL PERIPHERAL** 0.4A 0 SG55451B/75451B 2. High-speed switching. POSITIVE AND DRIVER. A 3. TTL or DTL compatible diode-EVICE 0.3A SG55461/75461 clamped inputs. \*\* 0 SG55471/7547<sup>\*</sup> A PAGE # 10-27 74 0 \*\* SG55451B = 30V, SG55461 = 35V, and SG55471 = 70V TYPE FEATURES DESCRIPTION 1. Two NAND gates with open CHARACTERISTICS S **DUAL PERIPHERAL** 0.4A 0 SG55459B/75459B 2. High-speed switching. NAND DRIVER. 3. TTL or DTL compatible diode-A EVICE 0.3A SG55462/75462 X U SG55472/75472 KEY A PAGE # 10-29 77 \*\* SG55452B = 30V, SG55462 = 35V, and SG55472 = 70V H DESCRIPTION FEATURES 1. Two OR gates with open collector CHARACTERISTICS **DUAL PERIPHERAL** 0.4A 9 2. High-speed switching. OR DRIVER. A EVICE 3. TTL or DTL compatible diode-0.3A SG55463/75463 clamped inputs. × U SG55473/75473 KEY A PAGE # 10-31 77 \*\* SG55453B = 30V, SG55463 = 35V, and SG55473 = 70V FEATURES DESCRIPTION 1. Two NOR gates with open CHARACTERISTICS collector outputs. **DUAL PERIPHERAL** SG55454B/75454B 0.4A 0 2. High-speed switching. NOR DRIVER. 3. TTL or DTL compatible diode-A EVICE 0.3A SG55464/75464 clamped inputs. × \*\* 0 SG55474/75474 A PAGE # 10-33 77 \*\* SG55454B = 30V, SG55464 = 35V, and SG55474 = 70V

#### OTHER LINEAR CIRCUITS

#### Transistor Arrays

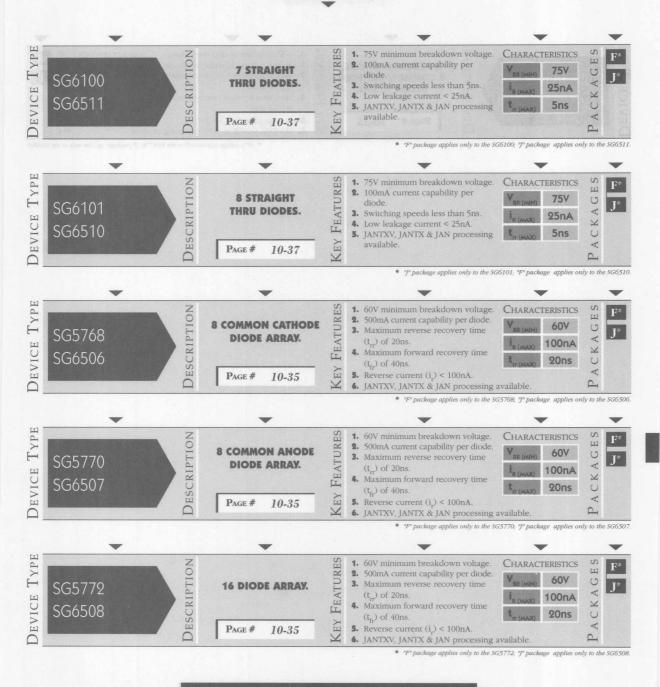


#### Sense Amplifiers



#### OTHER LINEAR CIRCUITS

Diode Arrays

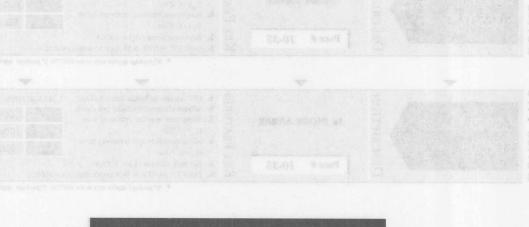


#### OTHER LINEAR CIRCUITS

Diode Arrays



\* "F" package applies only to the SG5774; "J" package applies only to the SG6509





# SG2000 Series

#### HIGH VOLTAGE MEDIUM CURRENT DRIVER ARRAYS

THE INFINITE POWER OF INNOVATION PRODUCTION DATA SHEET

#### DESCRIPTION

The SG2000 series integrates seven NPN Darlington pairs with internal suppression diodes to drive lamps. relays, and solenoids in many military, aerospace, and industrial applications that require severe environments. All units feature open collector outputs with greater than 50V breakdown voltages combined with 500mA current carrying capabilities. Five different input configurations provide optimized

designs for interfacing with DTL, TTL, PMOS, or CMOS drive signals. These devices are designed to operate from -55°C to 125°C ambient temperature in a 16-pin dual in line ceramic (I) package and 20-pin Leadless Chip Carrier (LCC). The plastic dual in-line (N) is designed to operate over the commercial temperature range of 0°C to 70°C.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

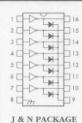
#### KEY FEATURES

- SEVEN NPN DARLINGTON PAIRS
- -55°C TO 125°C AMBIENT OPERATING TEMPERATURE RANGE
- COLLECTOR CURRENTS TO 600mA
- OUTPUT VOLTAGES FROM 50V TO 95V
- INTERNAL CLAMPING DIODES FOR INDUCTIVE LOADS
- DTL, TTL, PMOS, OR CMOS COMPATIBLE **INPUTS**
- HERMETIC CERAMIC PACKAGE

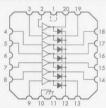
#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- MIL-M38510/14101BEA JAN2001J
- MIL-M38510/14102BEA JAN2002J
- MIL-M38510/14103BEA JAN2003J
- MIL-M38510/14104BEA JAN2004J
- LINFINITY LEVEL "S" PROCESSING AVAIL.

# PACKAGE PIN OUTS



(Top View)



L PACKAGE (Top View)

	PACKAGE O	RDER INFORMA	TION
T <sub>A</sub> (°C)	N Plastic Dip 16-pin	J Ceramic Dip 16-pin	L Ceramic LCC 20-pin
0 4- 70	SG2003N	_	_
0 to 70	SG2023N	_	
-55 to 125	_	SG20xxJ	SG20xxL
MIL-STD-883	_	SG20xxJ/883B	SG20xxL/883B
DESC	- II - II	SG20xxJ/DESC	_
		JAN2001J	
		JAN2002J	
JAN	-	JAN2003J	
		JAN2004J	_

"xx" is determined by selection guide, see next page.

# SG2000 Series

# HIGH-VOLTAGE MEDIUM CURRENT DRIVER ARRAYS

#### TEST CATA C MOIT PRODUCTION DATA SHEET

#### SELECTION GUIDE

Device	V <sub>CE</sub> Max	I <sub>c</sub> Max	Logic Inputs
SG2001	50V	500mA	General Purpose PMOS, CMOS
SG2002	50V	500mA	14V-25V PMOS
SG2003	50V	500mA	5V TTL, CMOS
SG2004	50V	500mA	6V-15V CMOS, PMOS
SG2011	50V	600mA	General Purpose PMOS, CMOS
SG2012	50V	600mA	14V-25V PMOS
SG2013	50V	600mA	5V TTL, CMOS
SG2014	50V	600mA	6V-15V CMOS, PMOS
SG2015	50V	600mA	High Output TTL
SG2021	95V	500mA	General Purpose PMOS, CMOS
SG2023	95V	500mA	5V TTL, CMOS
SG2024	95V	500mA	6V-15V CMOS, PMOS





# SG2800 Series

HIGH VOLTAGE MEDIUM CURRENT DRIVER ARRAYS

THE INFINITE POWER OF INNOVATION PRODUCTION DATA SHEET

#### DESCRIPTION

The SG2800 series integrates eight NPN Darlington pairs with internal suppression diodes to drive lamps, relays, and solenoids in many military, aerospace, and industrial applications that require severe environments. All units feature open collector outputs with greater than 50V breakdown voltages combined with 500mA current

carrying capabilities. Five different input configurations provide optimized designs for interfacing with DTL, TTL, PMOS, or CMOS drive signals. These devices are designed to operate from -55°C to 125°C ambient temperature in an 18-pin dual in line ceramic (J) package and 20-pin Leadless Chip Carrier (LCC).

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

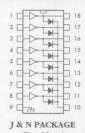
#### KEY FEATURES

- EIGHT NPN DARLINGTON PAIRS
- COLLECTOR CURRENTS TO 600mA
- OUTPUT VOLTAGES FROM 50V TO 95V
- INTERNAL CLAMPING DIODES FOR INDUCTIVE LOADS
- DTL, TTL, PMOS, OR CMOS COMPATIBLE INPUTS
- HERMETIC CERAMIC PACKAGE

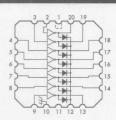
#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B AND DESC SMD
- MIL-M38510/14106BVA JAN2801J
- MIL-M38510/14107BVA JAN2802J
- MIL-M38510/14108BVA JAN2803J ■ MIL-M38510/14109BVA - JAN2804J
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

#### PACKAGE PIN OUTS







L PACKAGE (Top View)

	PACKAGE OF	EDER INFORMA	TION
T <sub>A</sub> (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	L Ceramic LCC 20-pin
-55 to 125	SG2803N	SG28xxJ	SG28xxL
-33 to 123	SG2823N		_
MIL-STD-883		SG28xxJ/883B	SG28xxL/883B
	_	SG2803J/DESC	SG2803L/DESC
DESC	_	SG2821J/DESC	SG2821L/DESC
DESC		SG2823J/DESC	SG2823L/DESC
	_	SG2824J/DESC	SG2824L/DESC
	_	JAN2801J	_
		JAN2802J	
JAN	_	JAN2803J	_
		JAN2804J	_

"xx" is determined by selection guide, see next page.

FOR FURTHER INFORMATION CALL (714) 898-8121

#### THE AVAIL HOLT PRODUCTION DATA SHEET TO REPORT THE SHE

#### SELECTION GUIDE

Device .	V <sub>CE</sub> Max	I <sub>c</sub> Max	Logic Inputs
SG2801	50V	500mA	General Purpose PMOS, CMOS
SG2802	50V	500mA	14V-25V PMOS
SG2803	50V	500mA	5V TTL, CMOS
SG2804	50V	500mA	6V-15V CMOS, PMOS
SG2811	50V	600mA	General Purpose PMOS, CMOS
SG2812	50V	600mA	14V-25V PMOS
SG2813	50V	600mA	5V TTL, CMOS
SG2814	50V	600mA	6V-15V CMOS, PMOS
SG2815	50V	600mA	High Output TTL
SG2821	95V	500mA	General Purpose PMOS, CMOS
SG2823	95V	500mA	5V TTL, CMOS
SG2024	95V	500mA	6V-15V CMOS, PMOS







TRANSISTOR ARRAY

THE INFINITE POWER OF INNOVATION PRODUCTION DATA SHEET

#### DESCRIPTION

The SG3081 has seven high-current silicon NPN transistors integrated into seven emitters common. The device has a separate substrate pin for more versatile applications. With current

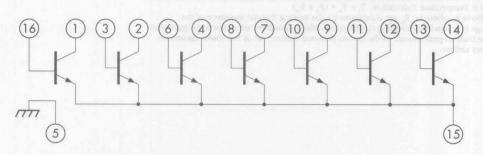
capability to 100mA per transistor, this array is ideally suited for driving a single monolighic chip and has all all types of seven-segment displays as well as other general purpose driver applications.

#### KEY FEATURES

- COLLECTOR CURRENT TO 100mA
- LOW SATURATION VOLTAGE
- CLOSELY MATCHED PARAMETERS

#### PRODUCT HIGHLIGHT

SG3081 SCHEMATIC DIAGRAM



PACKAGE	ORDER INFO
T <sub>A</sub> (°C)	J Ceramic DIP 16-pin
-55 to 125	SG3081J
MIL-STD-883B	SG3081J/993B
DESC	SG3081J/DESC

FOR FURTHER INFORMATION CALL (714) 898-8121

#### TRANSISTOR ARRAY

#### TEER 2 ATA G HOLT PRODUCTION DATA SHEET TO REVOLUTION BATA

#### 

#### THERMAL DATA

#### J PACKAGE:

HEROTO IN THE TOTAL CONTROL OF THE PROPERTY O	
THERMAL RESISTANCE-JUNCTION TO CASE, $\theta_{_{JC}}$	30°C/W
THERMAL RESISTANCE-JUNCTION TO AMBIENT, θ.	80°C/W

Junction Temperature Calculation:  $T_J = T_A + (P_D \times \theta_{JA})$ . The above numbers for  $\theta_{JC}$  are maximums for the limiting thermal resistance of the package in a standard mounting configuration. The  $\theta_{JA}$  numbers are meant to be guidelines for the thermal performance of the device/pc-board system. All of the above assume no ambient airflow.

#### PACKAGE PIN OUTS

C1		1	16	þ	B1
C2	d	2	15	b	COMMON EMITTER
B2		3	14	Ь	C7
В3		4	13		B7
GROUND					
C3		6	11	1	B6
C4	d	7	10		B5
B4	d	8	9	Ь	C5

J PACKAGE (Top View)





# TRANSISTOR ARRAY

#### PRODUCTION DATA SHEET

RECOMMENDED OPERATING CONDITIONS (Note 2)									
Downston	Combal	Recommen	Units						
Parameter	Symbol	Min.	Тур.	Max.	Units				
Collector to Emitter Voltage	V <sub>CEO</sub>		16		V				
Collector to Base Voltage	V <sub>CBO</sub>		20		V				
Collector to Substrate Voltage	V <sub>cso</sub>		20		٧				
Emitter to Base Voltage	V <sub>EBO</sub>		5		V				
Collector Current	I <sub>c</sub>		100		mA				
Base Current	I <sub>B</sub>		20		mA				
Operating Ambient Temperature Range:					1000				
SG3081		-55		125	°C				

Note 2. Range over which the device is functional.

-

#### ELECTRICAL CHARACTERISTICS (Note 3)

(Unless otherwise specified, these specifications apply over the operating ambient temperature. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Symbol	Test Conditions		SG3081		
raiailletei	Sylliooi	rest conditions	Min.	Min. Typ.	Max.	Units
Collector-Base Breakdown Voltage	BV <sub>CBO</sub>	$I_{c} = 500 \mu A, I_{E} = 0$	5.05	5.10	5.15	٧
Collector-Substrate Breakdown Voltage	BV <sub>cso</sub>	$I_{ci} = 500 \mu A, I_{E} = 0, I_{B} = 0$		0.2	5	mV
Collector-Emitter Breakdown Voltage	BV <sub>CEO</sub>	$I_{c} = 500 \mu A, I_{B} = 0$		3	15	mV
Emitter-Base Breakdown Voltage	BV <sub>EBO</sub>	$I_{c} = 500 \mu A$			0.4	mV/°C
DC Forward-Current Transfer Ratio	h <sub>FE</sub>	$V_{cE} = 5.0V, I_{c} = 30mA$	5.00		5.20	٧
		$T_A = 25$ °C		50		μV <sub>RMS</sub>
		$V_{ce} = 5.0V, I_c = 50mA$		5	25	mV
		$T_A = 25$ °C	-15	-50	-100	mA
Base-Emitter Saturation Voltage	V <sub>BEsat</sub>	$I_C = 30\text{mA}, I_B = 1\text{mA}$				
		$T_A = 25$ °C				
Collector-Emitter Saturation Voltage	V <sub>CEsat</sub>	$I_{c} = 30\text{mA}, I_{B} = 1\text{mA}$				
		$I_{c} = 30\text{mA}, I_{B} = 1\text{mA}, T_{A} = 25^{\circ}\text{C}$		is a		
		$I_{c} = 50 \text{mA}, I_{B} = 5 \text{mA}$				
		$T_A = 25$ °C				
Collector-Cutoff-Current	I <sub>CEO</sub>	$V_{CE} = 10V, I_{B} = 0$				
		$T_A = 25$ °C				
Collector-Cutoff Current	I <sub>CBO</sub>	$V_{CB} = 10V, I_{E} = 0$				
		T <sub>A</sub> = 25°C			1000	





SG55236

### DUAL SENSE AMPLIFIER / DATA REGISTERS

THE INFINITE POWER OF INNOVATION

NOT RECOMMENDED FOR NEW DESIGNS

#### DESCRIPTION

The SG55236 is a monolithic, dual channel, high-speed sense amplifier with independently-controlled data registers. The input section features an adjustable differential-input threshold voltage. All four inputs of the sense amplifier have been screened to guarantee threshold matching (see  $\Delta_{\rm TH}$  in electrical characteristics).

Separate detector outputs for each channel allow the designer the flexibility to use additional output stages if necessary. In addition, each of the data registers has provisions for external data inputs. The SG55236 is available in a 24-pin flat pack and is characterized over the full military ambient temperature range of -55°C to 125°C.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

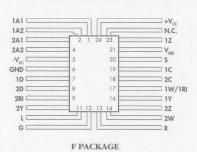
#### KEY FEATURES

- THRESHOLD VOLTAGE MATCHING ( $\Delta V_{TH}$ ): SG55236 1.5mV
- ADJUSTABLE DIFFERENTIAL-INPUT THRESHOLD VOLTAGE
- REFERENCE AMPLIFIER INHERENTLY STABLE WITH NO EXTERNAL FREQUENCY COMPENSATION REQUIRED
- BUILT-IN DATA REGISTER WITH PROVISIONS FOR EXTERNAL DATA INPUTS
- BUILT-IN DATA BUFFER DRIVES 450pF LOAD IN 15ns
- INTERNAL REFERENCE VOLTAGE ATTENUATOR MAKES REFERENCE AMPLIFIER LESS SENSITIVE TO NOISE

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

### PACKAGE PIN OUTS



### PACKAGE ORDER INFO

(Top View)

T <sub>A</sub> (°C)	F Ceramic Flat Pack 24-pin
-55 to 125	SG55236F
MIL-STD-883	SG55236F/883B





# SG55325/SG75325

QUAD SOURCE/DUAL SINK MEMORY DRIVER

THE INFINITE POWER OF INNOVATION

NOT RECOMMENDED FOR NEW DESIGNS

#### DESCRIPTION

The SG55325/75325 is a monolithic dual source/dual sink driver designed to meet the high current and fast switching speed requirements of magnetic memory systems. Each driver can be independently selected through separate input logic. Also, each pair of drivers (sink of source pairs) has a separate strobe input to allow control of either pair of drivers. Each driver of the SG55325/75325 can switch 600mA.

Although used extensively in magnetic memory systems, this versatile driver has been used to drive relays, lamps, and small motors as well as being used as the driver in a clock circuit.

The SG55325 is characterized for use over the military ambient temperature range of -55° to 125°C. The SG75325 has an operating ambient temperature range of 0° to 70°C.

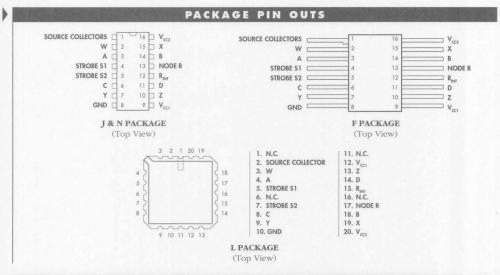
COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### KEY FEATURES

- 600mA OUTPUT CAPABILITY
- FAST SWITCHING TIMES
- OUTPUT SHORT-CIRCUIT PROTECTION
- 24V OUTPUT CAPABILITY
- SOURCE BASE DRIVE EXTERNALLY
  AD JUSTABLE
- TTL OR DTL COMPATIBILITY
- INPUT CLAMPING DIODES

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- MIL-M-38510/13001BEA JAN55325J
- MIL-M-38510/13001BFA JAN55325F
- RADIATION DATA AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.



	PACK	AGE ORDER IN	FORMATION	
T <sub>A</sub> (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	F Ceramic Flat Pack 16-pin	L Ceramic LCC 20-pin
0 to 70	SG7532N	SG7532J	_	_
-55 to 125	_	SG55325J	SG55325F	_
MIL-STD-883	_	SG55325J/883B	SG55325F/883B	SG55325L/883B

or Recommended for New Designs

### NOT STEEL

The \$65532775325 is a monolithic dual source dual source dual source data sink driver designed to meet the high current and fast switching speed requiertentits of magnetic namon's systems. Each driver can be independently selected through separate input logic. Also, each pas of drivers (sink of source pairs) has a separate stoke input to flow control of either pair of drivers. Each driver of the

Although used extensively in negment memory systems, this versaide driver has been used to drive relays, lamps, not small nemors as well as being used as the driver in a clock circuit.

The 8055025 is characterized for use over the military amideal temperature range of 557 to 1370. The 8075525 has no operating ambient temperature range of 62 to 70%.

#### CARUTAST YTHERALIST

- M AVAILABLE TO MIL-STD-6838
- NEL-M-38510/130018EA JA1553251
  - ME-M-38510/130018FA JAMS5395
  - PARAMETER DATA AVAILABLE
- Manage Secure and American Company of the Company o

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIM" FAX SYSTEM







## SG55326/SG75326

### QUAD SINK MEMORY DRIVER

THE INFINITE POWER OF INNOVATION

NOT RECOMMENDED FOR NEW DESIGNS

#### DESCRIPTION

The SG55326/SG75326 is a monolithic quad positive-OR sink driver designed to meet the high current and fast switching speed requirements of magnetic memory systems. Each driver is independently controlled and capable of sinking up to 600mA.

Paired with the SG55327 Quad Source Driver, the SG55326/SG75326 provides the current drive necessary for many sink/source applications.

Although designed specifically for magnetic memory applications, the

SG55326/SG75326 has been used to drive clock circuits, relays, lamps, and small motors, or any application where a 600mA sink driver is needed.

The SG55326 is characterized for use over the full military operating ambient temperature of -55° to 125°C while the SG75326 is characterized over the operating ambient temperature of 0° to 70°C.

These devices are available in 16-pin ceramic DIP, 16-pin plastic DIP and 16-pin flatpack.

#### KEY FEATURES

- 600mA OUTPUT CURRENT SINK CAPABILITY
- 24V OUTPUT CAPABILITY
- CLAMP VOLTAGE VARIABLE TO 24V
- HIGH-REPETITION-RATE DRIVER COMPATIBLE WITH HIGH-SPEED MAGNETIC MEMORIES
- INPUTS COMPATIBLE WITH TTL LEVEL DECODERS
- MINIMUM TIME SKEW BETWEEN STROBE AND OUTPUT CURRENT RISE
- PULSE-TRANSFORMER COUPLING ELIMINATED
- DRIVE-LINE LENGTHS REDUCED

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- MIL-M-38510/13001BEA JAN55326J
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### PACKAGE PIN OUTS GND [ 16 CLAMP W, Z GND CLAMP W, Z W 🗆 2 15 🗆 Z W 15 ¬ Z 14 D 14 A | 3 AF T D 13 S 13 □ S □ V<sub>cc</sub> 12 V V CC N.C. 12 11 C C ⊐ c B [ 6 BE X 10 □ Y 9 CLAMP X, Y GND (Note 1) GND -CLAMP X, Y J & N PACKAGE F PACKAGE (Top View) (Top View) Note 1: Pin 8 is in electrical contact with the metal base.

	PACKAGE OF	RDER INFORMA	TION
T <sub>A</sub> (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	F Ceramic Flat Pack 16-pin
0 to 70	SG75326N	SG75326J	_
-55 to 125	_	SG55326J	SG55326F
MIL-STD-883	_	SG55326J/883B	SG55326F/883B

FOR FURTHER INFORMATION CALL (714) 898-8121

- W CLAMP VOLTAGE VARIABLE TO SAV

	[D9]. <sub>2</sub> 3





### SG55327/SG75327

### QUAD SOURCE MEMORY DRIVER

THE INFINITE POWER OF INNOVATION

NOT RECOMMENDED FOR NEW DESIGNS

#### DESCRIPTION

The SG55327/SG75327 is a monolithic quad source driver designed to meet the high current and fast switching speed requirements of magnetic memory systems. Each driver is independently controlled and capable of sinking up to 600mA.

Paired with the SG55326 Quad Sink Driver, the SG55327/SG75327 provides the current drive necessary for many sink/source applications.

The SG55327/SG75327 has also been used in many non-memory applications: for example, as the driver for a clock circuit, relay, lamp, or small motor, or any application where a 600mA source driver is needed.

The SG55327 is characterized for use over the full military operating ambient temperature range of -55° to 125°C while the SG75327 is characterized from 0° to 70°C.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

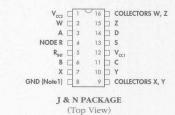
#### KEY FEATURES

- QUAD SOURCE MEMORY DRIVERS
- 500mA OUTPUT CURRENT CAPABILITY
- V<sub>cco</sub> DRIVE VOLTAGE VARIABLE TO 24V
- OUTPUT CAPABLE OF SWINGING BETWEEN V<sub>CCQ</sub> AND GROUND
- HIGH-REPETITION-RATE DRIVER
   COMPATIBLE WITH HIGH-SPEED MAGNETIC
   MEMORIES
- INPUTS COMPATIBLE WITH TTL DECODERS
- MINIMUM TIME SKEW BETWEEN STROBE AND OUTPUT-CURRENT RISE
- PULSE-TRANSFORMER COUPLING ELIMINATED
- DRIVE-LINE LENGTHS REDUCED

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- SCHEDULED FOR MIL-M-38510 QPL LISTING
- LINFINITY LEVEL "S" PROCESSING AVAIL.

#### PACKAGE PIN OUTS



Note 1: Pin 8 is in electrical contact with the metal base.



(Top View)

	PACKAGE OF	RDER INFORMA	TION
T <sub>A</sub> (°C)	N Plastic DIP 16-pin	J Ceramic DIP 16-pin	F Ceramic Flat Pack 16-pin
0 to 70	SG75327N	SG75327J	_
-55 to 125	. 12x4116 <del>-</del> . 1016	SG55327J	SG55327F
MIL-STD-883		SG55327J/883B	SG55327F/883B

FOR FURTHER INFORMATION CALL (714) 898-8121

M V ... DRIVE VOLTAGE VARIABLE TO SHV

X.W. SECTORICO	





### SG55450B/SG75450B Series

### DUAL PERIPHERAL POSITIVE-AND DRIVER

THE INFINITE POWER OF INNOVATION

NOT RECOMMENDED FOR NEW DESIGNS

#### DESCRIPTION

The SG55450B/SG55460/SG55470 (SG75450B/SG75460/SG75470) series of dual peripheral Positive-AND drivers are a family of versatile devices designed for use in systems that employ TTL or DTL logic. This family of drivers are direct replacements for the Texas Instruments SN55450B/60/70 (SN75450B/60/70) series. Diodeclamped inputs simplify circuit design. Typical applications include high-speed logic buffers, power drivers, relay drivers, MOS drivers, line drivers, and memory drivers. These parts are

unique general-purpose devices each featuring two standard Series 54/74 TTL gates and two uncommitted, highcurrent, high-voltage n-p-n transistors and offer the system designer the flexibility of tailoring the circuit to the application. The SG55450B/SG55460/ SG55470 drivers are characterized for operation over the full military ambient temperature range of -55° to 125°C and the SG75450B/SG75460/SG75470 drivers are characterized for operation from 0° to 70°C.

#### KEY FEATURES

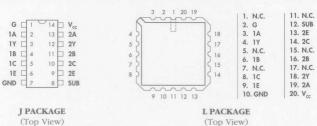
- 300mA OUTPUT CURRENT CAPABILITY
- HIGH-VOLTAGE OUTPUT
- NO OUTPUT LATCH-UP AT 20V
- HIGH SPEED SWITCHING
- TTL OR DTL COMPATIBLE DIODE-CLAMPED
- STANDARD SUPPLY VOLTAGE

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- SCHEDULED FOR MIL-M-38510 QPL LISTING
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

### PACKAGE PIN OUTS



(Top View)

### PACKAGE ORDER INFORMATION

T <sub>A</sub> (°C)	J Ceramic DIP 14-pin	L Ceramic LCC 20-pin
	SG75450BJ	_
0 to 70	SG75460J	_
	SG75470J	_
	SG55450BJ	SG55450BL
-55 to 125	SG55460J	SG55460L
	SG55470J	SG55470L
	SG55450BJ/883B	SG55450BL/883B
MIL-STD-883	SG55460J/883B	SG55460L/883B
	SG55470J/883B	SG55470L/883B

FOR FURTHER INFORMATION CALL (714) 898-8121





### **SG55451B/SG75451B Series**

DUAL PERIPHERAL POSITIVE-AND DRIVER

THE INFINITE POWER OF INNOVATION

NOT RECOMMENDED FOR NEW DESIGNS

### DESCRIPTION

The SG55451B/SG55461/SG55471 (SG75451B/SG75461/SG75471) series of dual peripheral Positive-AND drivers are a family of versatile devices designed for use in systems that employ TTL or DTL logic. This family of drivers are direct replacements for the Texas Instruments SN55451B/61/71 (SN7451B/61/71) series. Diodeclamped inputs simplify circuit design.

Typical applications include high-speed logic buffers, power drivers, relay drivers, line drivers, and memory drivers. The SG55451B/SG55461/SG55471 drivers are characterized for operation over the full military ambient temperature range of -55°C to 125°C and the SG75451B/SG75461/SG75471 drivers are characterized for operation from 0°C to 70°C.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

### KEY FEATURES

- 300mA OUTPUT CURRENT CAPABILITY
- HIGH-VOLTAGE OUTPUT
- NO OUTPUT LATCH-UP AT 20V
- HIGH SPEED SWITCHING
- TTL OR DTL COMPATIBLE DIODE-CLAMPED INPUTS
- STANDARD SUPPLY VOLTAGE

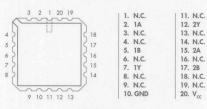
#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- SCHEDULED FOR MIL-M-38510 QPL LISTING
- LINFINITY LEVEL "S" PROCESSING AVAIL.

#### PACKAGE PIN OUTS



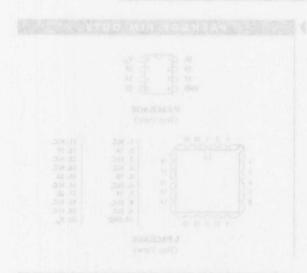
#### Y PACKAGE (Top View)



L PACKAGE (Top View)

#### PACKAGE ORDER INFORMATION

T <sub>A</sub> (°C)	Y Ceramic DIP 8-pin	L Ceramic LCC 20-pin
	SG75451BY	
0 to 70	SG75461Y	_
	SG75471Y	_
	SG55451BY	SG55451BL
-55 to 125	SG55461Y	SG55461L
	SG55471Y	SG55471L
	SG55451BY/883B	SG55451BL/883B
MIL-STD-883	SG55461Y/883B	SG55461L/883B
	SG55471Y/883B	SG55471L/883B







### **SG55452B/SG75452B Series**

### DUAL PERIPHERAL POSITIVE-NAND DRIVER

THE INFINITE POWER OF INNOVATION

NOT RECOMMENDED FOR NEW DESIGNS

#### DESCRIPTION

The SG55452B/SG55462/SG55472 (SG75452B/SG75462/SG75472) series of dual peripheral Positive-NAND drivers are a family of versatile devices designed for use in systems that employ TTL or DTL logic. This family of drivers are direct replacements for the Texas Instruments SN55452B/62/72 (SN75452B/62/72) series. Diodeclamped inputs simplify circuit design.

Typical applications include high-speed logic buffers, power drivers, relay drivers, MOS drivers, line drivers, and memory drivers. The SG55452B/SG55462/SG55472 drivers are characterized for operation over the full military ambient temperature range of -55°C to 125°C and the SG75452B/SG75462/SG75472 drivers are characterized for operation from 0°C to 70°C.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### KEY FEATURES

- 300mA OUTPUT CURRENT CAPABILITY
- HIGH-VOLTAGE OUTPUT
- NO OUTPUT LATCH-UP AT 20V
- HIGH SPEED SWITCHING
- TTL OR DTL COMPATIBLE DIODE-CLAMPED INPUTS
- STANDARD SUPPLY VOLTAGE

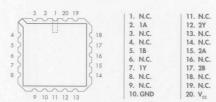
#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- SCHEDULED FOR MIL-M-38510 QPL LISTING
- LINFINITY LEVEL "S" PROCESSING AVAIL.

#### PACKAGE PIN OUTS



#### Y PACKAGE (Top View)



L PACKAGE (Top View)

# T<sub>A</sub> (°C) Y Ceramic DIP 8-pin L Ceramic LCC 20-pin

The state of the s	3073432BT	
0 to 70	SG75462Y	
	SG75472Y	- 1. T.
	SG55452BY	SG55452BL
-55 to 125	SG55462Y	SG55462L
	SG55472Y	SG55472L
	SG55452BY/883B	SG55452BL/883B
MIL-STD-883	SG55462Y/883B	SG55462L/883B
	SG55472Y/883B	SG55472L/883B
DESC	SG55452BY/DESC	SG55452BL/DESC
JAN	JAN55452BY	_

FOR FURTHER INFORMATION CALL (714) 898-8121

OF RECOMMENDED FOR NEW DESIGNS

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### DESCRIPTION OF THE PROPERTY OF

- M. SOURA CUTFUT CURRENT CAPABILITY
  - TURNO TRATIONAMENT
  - IN NO CUITPUT LATCH-UP AT 90V
    - DMHOTIWE 03998 Halls #
- M TRUOR DR. COMPATIBLE DIODG-CLAMPED
  - STATIONARD SUPPLIA VOLTAGE

#### CERUTAGE TIMBALISE HOLT

- SESS-OTS-JIM OT BIBAJIAVA .
- M SUHFBULED FOR MIL-M-385 TO GRU USTRING
- UNINERTY LEVEL 1ST PROCESSING AVAIL.

Typical applications include high-speed logic buffers, power drivers, relay driven 2005 drivers. The 8058452R-8055442 drivers. The 8058452R-8055442 5053472 drivers and dutacterized for operation error the full inflarey ambient temperature ripide of -85°C to 125°C maperature ripide of -85°C to 125°C and the 8078452R-807842 8078472 to the second of the second of the second to the second of the second of the second to the second of the second of the second to the second of the second of the second the second of the second of the second of the second the second of the secon

The SGS+52B SGCF5462/SGCF472 scrime of SGCF452B/SGCF5462/SGCF472) scrime of lual peripheral Positive-NAND circus; are a family of versatile devices (esigned for use in systems that employ 17L or DTL logic. This family of drivers are direct replacements for the Texas instruments SGS5/52B/6272 SMF55/52B/62T2 Series. Doodle-

COMPLETE SHEEDGHS AVAILABLE ROOM "LIM!" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SHEEGH GERBINAL DAYABOOK







### **SG55453B/SG75453B Series**

DUAL PERIPHERAL POSITIVE-OR DRIVER

NOT RECOMMENDED FOR NEW DESIGNS

### THE INFINITE POWER OF INNOVATION

#### DESCRIPTION

The SG55453B/SG55463/SG55473 (SG75453B/SG75463/SG75473) series of dual peripheral Positive-OR drivers are a family of versatile devices designed for use in systems that employ TTL or DTL logic. This family of drivers are direct replacements for the Texas Instruments SN55453B/63/73 (SN75453B/63/73) series. Diodeclamped inputs simplify circuit design.

Typical applications include high-speed logic buffers, power drivers, relay drivers, MOS drivers, line drivers, and memory drivers. The SG55453B/SG55463/SG55473 drivers are characterized for operation over the full military ambient temperature range of -55°C to 125°C and the SG75453B/SG75463/SG75473 drivers are characterized for operation from 0°C to 70°C.

#### **KEY FEATURES**

- 300mA OUTPUT CURRENT CAPABILITY
- HIGH-VOLTAGE OUTPUT
- NO OUTPUT LATCH-UP AT 20V
- HIGH SPEED SWITCHING
- TTL OR DTL COMPATIBLE DIODE-CLAMPED
- STANDARD SUPPLY VOLTAGE

#### HIGH RELIABILITY FEATURES

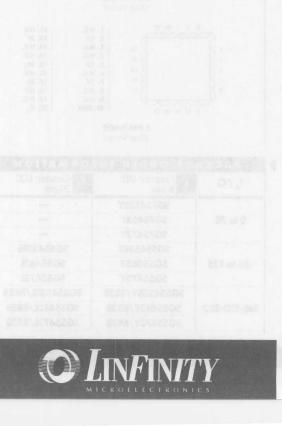
- AVAILABLE TO MIL-STD-883B
- SCHEDULED FOR MIL-M-38510 QPL LISTING
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### PACKAGE PIN OUTS 1A 1B 2B 1Y 2A GND 2Y Y PACKAGE (Top View) 1. N.C. 11. N.C. 2. 1A 12. 2Y 3. N.C. 13. N.C. 4. N.C. 17 5. 1B 15. 2A ( 16 6. N.C. 16. N.C. 15 7. 1Y 17. 2B 8. N.C. 18. N.C. 9 NC 19. N.C. 9 10 11 12 13 10. GND 20. V<sub>cc</sub> L PACKAGE (Top View)

PACKA	GE ORDER IN	FORMATION
T <sub>A</sub> (°C)	Y Ceramic DIP 8-pin	L Ceramic LCC 20-pin
	SG75453BY	_
0 to 70	SG75463Y	_
	SG75473Y	_
	SG55453BY	SG55453BL
-55 to 125	SG55463Y	SG55463L
	SG55473Y	SG55473L
	SG55453BY/883B	SG55453BL/883B
MIL-STD-883	SG55463Y/883B	SG55463L/883B
	SG55473Y/883B	SG55473L/883B

FOR FURTHER INFORMATION CALL (714) 898-8121





### **SG55454B/SG75454B Series**

### DUAL PERIPHERAL POSITIVE-NOR DRIVER

THE INFINITE POWER OF INNOVATION

NOT RECOMMENDED FOR NEW DESIGNS

#### DESCRIPTION

The SG55454B/SG55464/SG55474 (SG75454B/SG75464/SG75474) series of dual peripheral Positive-NOR drivers are a family of versatile devices designed for use in systems that employ TTL or DTL logic. This family of drivers are direct replacements for the Texas Instruments SN55454B/64/74 (SN75454B/64/74) series. Diodeclamped inputs simplify circuit design.

Typical applications include high-speed logic buffers, power drivers, relay drivers, MOS drivers, line drivers, and memory drivers. The SG55454B/SG55464/SG55474 drivers are characterized for operation over the full military ambient temperature range of -55°C to 125°C and the SG75453B/SG75463/SG75473 drivers are characterized for operation from 0°C to 70°C.

#### KEY FEATURES

- 300mA OUTPUT CURRENT CAPABILITY
- HIGH-VOLTAGE OUTPUT
- NO OUTPUT LATCH-UP AT 20V
- HIGH-SPEED SWITCHING
- TTL OR DTL COMPATIBLE DIODE-CLAMPED
- STANDARD SUPPLY VOLTAGE

#### HIGH RELIABILITY FEATURES

- AVAILABLE TO MIL-STD-883B
- SCHEDULED FOR MIL-M-38510 QPL LISTING
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### PACKAGE PIN OUTS 1. N.C. 2. 1A 12. 2Y 3. N.C. 13. N.C. 4. N.C. 14. N.C. 1A 17 5. 1B 15. 2A 1B 2B 16 6. N.C. 16. N.C. 1Y 2A 15 7. 1Y 17. 2B GND 8. N.C. 18. N.C. 9. N.C. 19. N.C. 10. GND 20. V<sub>cc</sub> 9 10 11 12 13 Y PACKAGE L PACKAGE (Top View) (Top View)

PACKA	GE ORDER IN	FORMATION
T <sub>A</sub> (°C)	Y Ceramic DIP 8-pin	L Ceramic LCC 20-pin
	SG75454BY	_
0 to 70	SG75464Y	_
	SG75474Y	<del>-</del>
	SG55454BY	SG55454BL
-55 to 125	SG55464Y	SG55464L
	SG55474Y	SG55474L
	SG55454BY/883B	SG55454BL/883B
MIL-STD-883	SG55464Y/883B	SG55464L/883B
	SG55474Y/883B	SG55474L/883B
	<u> </u>	SG55454BL/DESC
DESC	SG55464Y/DESC	SG55464L/DESC
	SG55474Y/DESC	SG55474L/DESC



THE INFINITE POWER OF INNOVATION

### SG5768/SG5770/SG5772/SG5774 SG6506/SG6507/SG6508/SG6509

DIODE ARRAY CIRCUITS

PRODUCTION DATA SHEET

#### DESCRIPTION

The Linfinity series of diode arrays feature high breakdown, high speed diodes in a variety of configurations.

Each array configuration consists of either common anode diodes, common cathode diodes, or a combination anode and common cathode diodes.

Individual diodes within the array have 60V minimum breakdown

voltage, can handle 500mA of current and typically switch in less than 10 nanoseconds.

Each of the array configurations is available in ceramic DIP or ceramic flatpack and can be processed to JANTXV, JANTX, or JAN flows at Linfinity's MIL-S-19500 facility.

#### KEY FEATURES

- 60V MINIMUM BREAKDOWN VOLTAGE
- 500mA CURRENT CAPABILITY PER DIODE
- FAST SWITCHING SPEEDS: TYPICALLY LESS THAN 10ns
- LOW LEAKAGE CURRENT

#### HIGH RELIABILITY FEATURES

- MIL-S-19500/474 QPL 1N5768 1N6506
  - 1N5770 1N6507
  - 1N5772 1N6508
  - 1N5774 1N6509
- JANTXV, JANTX, JAN AVAILABLE
- LINFINITY LEVEL "S" PROCESSING AVAIL.

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### PACKAGE PIN OUTS 14 14 14 4 4 13 **N** N □ 13 12 **N** N 3 🗆 🕨 | | 12 | | | 11 12 2 = N N 4 🗆 11 10 -14 3 = N □ 8 <u>=</u> 10 4 = -14 **N** N N N 14 4 4 I PACKAGE F PACKAGE J PACKAGE F PACKAGE SG6506J (1N6506) SG5768F (1N5768) SG6508J (1N6508) SG5772F (1N5772) 1 14 1414 2 | 13 4 4 □ 13 2 1 13 1 12 3 🗆 4 4 3 4 1 12 2 🗆 3 □ ₩ 11 10 4 = 3 = 14 --7.8 **N** 10 5 □ 4 🗆 14 □ 10 NN N N 19 19 6 -N N J PACKAGE F PACKAGE J PACKAGE F PACKAGE SG6507J (1N6507) SG5770F (1N5770) SG6509J (1N6509) SG5774F (1N5774)

		EDER INFORMAT	
T <sub>A</sub> (°C)	J Ceramic DIP 14-pin	F Ceramic Flat Pack 10-pin	F Ceramic Flat Pack 14-pin
-55 to 150	SG6506J (1N6506)	SG5768F (1N5768)	SG5774F (1N6509)
	SG6507J (1N6507)	SG5770F (1N5770)	-
	SG6508J (1N6508)	SG5772F (1N5772)	_

FOR FURTHER INFORMATION CALL (714) 898-8121

PRODUCTION DATA SHELL

#### 20 图 4 T A 3 T 3 Y 3 X

- B 60V MINIMUM BREAKDOWN YOUTAGE
- Sport Carability Republic
- I FAST SWITCHING SPEEDS TYPICALLY LESS
  - IN LOW LEAKAGE CURRENT

#### SIGH RELIABILITY FEATURES

- ML 5-17500/174 CPL 1N5788 1N6506
- THEFTO THESOT
- BOSANT TITSHIT
- 11/5774 11/6509
  - I JANTAY JANTA, JAN AVAILABLE
  - HAVA-CHIPPS YOUR ST 19V6 (VIII-1966) 8

voltage, can handle 500mA of ourser not expically eviden in less than 10 remoseconds.

Pach of the array configurations is aveilable to commit DIP or commit full factors for facilities and can be processed to JAMENY, LAWEN, or JAM flows at Linfinity's MILS 19500 facility.

The Lithinity series of diode arrays feature high break-down, high spend diodes in a variety of configurations. Each array configuration consists of either common anode diodes, common cathode of codes, or a consistential anode and common cathode diodes. Individual diodes within the array

COMPLETE SPECIFICATIONS AVAILABLE FROM \*UNP\* FAX SYSTEM

PPACKAGE

F PACHAGE
SOUTH CONSTRAIN

FINANCIALIS.

J.P.ACECAGE

FEAGRAGE

SCETTUR (1KSYTO)



JPACKAGE NG650G (IN6506

J PACHENGE (196507) (196507)

TAPES 150 (1145503) (114572)





### SG6100/6511, SG6101/6510

DIODE ARRAY CIRCUITS

THE INFINITE POWER OF INNOVATION

PRODUCTION DATA SHEET

### DESCRIPTION

The SG6100/SG6511 and SG6101/SG6510 diode arrays are monolithic, high breakdown, fast switching speed diode arrays. The SG6100/SG6511 is configured with 7 straight through diodes, while the SG6101/SG6510 has 8 straight through diodes.

These two diode array configurations allow the designer maximum flexibility for circuit design and board layout. Since each diode within the array has

individual anode and cathode connections the device may be used in a variety of applications. Also, due to the array's monolithic construction the diode electrical parameters are very closely matched.

Both devices are available in ceramic DIP and flatpack and can be processed to Linfinity's S level, JANTXV, JANTX, of JAN equivalent flows.

#### KEY FEATURES

- 75V MINIMUM BREAKDOWN VOLTAGE
- 100mA CURRENT CAPABILITY PER DIODE
- SWITCHING SPEEDS LESS THAN 5ns
- LOW LEAKAGE CURRENT < 25na

### HIGH RELIABILITY FEATURES

- MIL-S-19500/474 QPL 1N6100
  - 1N6101
  - 1N6510
  - 1N6511
- EQUIVALENT JANS, JANTXV, JANTX, JAN SCREENING AVAILABLE

COMPLETE SPECIFICATIONS AVAILABLE FROM "LIN" FAX SYSTEM (SEE PAGE 4-1) AND 1990/91 SILICON GENERAL DATABOOK

#### PACKAGE PIN OUTS 13 2 = □ 13 12 3 □ 111 4 = 7 10 5 = □ 10 I PACKAGE F PACKAGE SG6511J (1N6511) SG6100 (1N6100) 15 2 🗆 15 114 3 🗆 113 13 12 11 6 □ □ 10 7 🗆 10 J PACKAGE F PACKAGE SG6101J (1N6101) SG6510 (1N6510)

	PACK	AGE ORDER	INFORMATION	
T <sub>A</sub> (°C)	J Ceramic DIP 14-pin	J Ceramic DIP 16-pin	F Ceramic Flat Pack 14-pin	F Ceramic Flat Pack 16-pin
-55 to 150	SG6511J (1N6511)	SG6101J (1N6101)	SG6100F (1N6100)	SG6510F (1N6510)



# Thumb Index

### Introduction

Quality

**Working With Linfinity** 

**Linfinity Information Network** 

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**Other Linear Circuits** 

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Representatives / Distributors

Ш



### APPROVED QML/QPL LISTINGS

### QML MILITARY PRODUCTS

LINFINITY Microelectronics Inc. offers a full line of Linear products which are processed in accordance with the requirements of MIL-I-38535, Qualified Manufacturers Listing (QML). Three Cross Reference Lists are provided:

- ▶ Cross Reference 1 All QML military products sorted by Generic Part # (below),
  - ▶ Cross Reference 2 All MIL-M-38510 (JAN) Qualified products (Page 11-13),
    - ▶ Cross Reference 

      All Standard Military Drawing (SMD) Qualified products (Page 11-14).

Three categories of QML Military Specification are provided (Note: Transitional Certification pending Verification Audit by DESC.):

- → Generic /883B (MIL-STD-883, Paragraph 1.2.1 compliant)
- → MIL-M-38510 (JAN)
- ► Standard Military Drawing (SMD)

See Page 11-17 for a listing of all QPL Products (JAN, JANTX, and JANTXV Processing Levels).

Cross Reference

Listing of all QML Certified military products sorted by Generic Part #.

Generic P (/883E	Section 19 and 1	MIL-M-38510 Part No. (JAN)	Standard MIL Drawing (SMD)	Description
Part No.	Pkg.		(Note 1)	
SG103-1.8	Z		7702801X(X)	Voltage Reference 1.8V
SG103-2.4	Z			Voltage Reference 2.4V
SG103-2.7	Z		7702805X(X)	Voltage Reference 2.7V
SG103-3.3	Z			Voltage Reference 3.3V
SG103-4.7	Z		7702811X(X)	Voltage Reference 4.7V
SG103-5.1	Z			Voltage Reference 5.1V
SG109	T	10701BX(X)		Positive Fixed Voltage Regulator
SG109	K			Positive Fixed Voltage Regulator
SG109	R			Positive Fixed Voltage Regulator
SG109	IG			Positive Fixed Voltage Regulator
SG117	T	11703BX(X)	7703401X(X)	Positive Adjustable Voltage Regulator
SG117	K	11704BY(X)	7703401Y(X)	Positive Adjustable Voltage Regulator
SG117	R		7703401Z(X)	Positive Adjustable Voltage Regulator
SG117	L		77034012(X)	Positive Adjustable Voltage Regulator
SG117	IG		7703401U(X)	Positive Adjustable Voltage Regulator
SG117A	T		7703405X(X)	Positive Adjustable Voltage Regulator
SG117A	K		7703405Y(X)	Positive Adjustable Voltage Regulator
SG117A	R		7703405Z(X)	Positive Adjustable Voltage Regulator
SG117A	L		77034052(X)	Positive Adjustable Voltage Regulator
SG117A	IG		7703405U(X)	Positive Adjustable Voltage Regulator
SGR117A	T			RadHard 1.5A Adjustable Voltage Regulator
SGR117A	K			RadHard 1.5A Adjustable Voltage Regulator
SGR117A	R		STREET, STREET	RadHard 1.5A Adjustable Voltage Regulator
SGR117A	IG			RadHard 1.5A Adjustable Voltage Regulator
SG120-05	R			Negative Fixed Voltage Regulator
SG120-05	K			Negative Fixed Voltage Regulator
SG120-05	T		BESTER BEST	Negative Fixed Voltage Regulator

Note 1: a. This number may be preceded by "5962-".
b. (X) denotes unspecified lead finish.



### APPROVED QML/QPL LISTINGS

All QML Products



		-	-	-	-		
1		4					1

(continued)						
Generic P (/883B		MIL-M-38510 Part No. (JAN)	Standard MIL Drawing (SMD)	Description		
Part No.	Pkg.		(Note 1)			
SG120-05	L			Negative Fixed Voltage Regulator		
SG120-05	IG			Negative Fixed Voltage Regulator		
SG120-5.2	R			Negative Fixed Voltage Regulator		
SG120-5.2	K			Negative Fixed Voltage Regulator		
SG120-5.2	T			Negative Fixed Voltage Regulator		
SG120-5.2	Lo			Negative Fixed Voltage Regulator		
SG120-5.2	IG			Negative Fixed Voltage Regulator		
SG120-08	R			Negative Fixed Voltage Regulator		
SG120-08	K			Negative Fixed Voltage Regulator		
SG120-08	T			Negative Fixed Voltage Regulator		
SG120-08	L			Negative Fixed Voltage Regulator		
SG120-08	IG			Negative Fixed Voltage Regulator		
SG120-12	R			Negative Fixed Voltage Regulator		
SG120-12	K			Negative Fixed Voltage Regulator		
SG120-12	T			Negative Fixed Voltage Regulator		
SG120-12	L			Negative Fixed Voltage Regulator		
SG120-12	IG			Negative Fixed Voltage Regulator		
SG120-15	R			Negative Fixed Voltage Regulator		
SG120-15	K			Negative Fixed Voltage Regulator		
SG120-15	T			Negative Fixed Voltage Regulator		
SG120-15	L			Negative Fixed Voltage Regulator		
SG120-15	IG			Negative Fixed Voltage Regulator		
SG120-18	R			Negative Fixed Voltage Regulator		
SG120-18	K			Negative Fixed Voltage Regulator		
SG120-18	T			Negative Fixed Voltage Regulator		
SG120-18	L			Negative Fixed Voltage Regulator		
SG120-18	IG			Negative Fixed Voltage Regulator		
SG120-20	R			Negative Fixed Voltage Regulator		
SG120-20	K			Negative Fixed Voltage Regulator		
SG120-20	T			Negative Fixed Voltage Regulator		
SG120-20	L			Negative Fixed Voltage Regulator		
SG120-20	IG			Negative Fixed Voltage Regulator		
SG120A-05	IG			Negative Fixed Voltage Regulator		
SG120A-5.2	IG			Negative Fixed Voltage Regulator		
SG120A-08	IG			Negative Fixed Voltage Regulator		
SG120A-12	IG			Negative Fixed Voltage Regulator		
SG120A-15	IG			Negative Fixed Voltage Regulator		
SG120A-18	IG		South subject to the	Negative Fixed Voltage Regulator		
SG120A-20	IG			Negative Fixed Voltage Regulator		
SG137	T	sobilities of period	7703403X(X)	Negative Fixed Voltage Regulator		
SG137	R		7703403Z(X)	Negative Fixed Voltage Regulator		

Note 1: a. This number may be preceded by "5962-". b. (X) denotes unspecified lead finish.



### APPROVED QML/QPL LISTINGS

All QML Products



(continued)							
Generic F (/883)		MIL-M-38510 Part No. (JAN)	Standard MIL Drawing (SMD)	Description			
Part No.	Pkg.		(Note 1)				
SG137	K	11804BY(X)	7703403Y(X)	Negative Fixed Voltage Regulator			
SG137	L		77034032(X)	Negative Fixed Voltage Regulator			
SG137	IG		7703403U(X)	Negative Fixed Voltage Regulator			
SG137A	T		7703406X(X)	Negative Adjustable Voltage Regulator - High Performance			
SG137A	K		7703406Y(X)	Negative Adjustable Voltage Regulator - High Performance			
SG137A	R		7703406Z(X)	Negative Adjustable Voltage Regulator - High Performance			
SG137A	L		77034062(X)	Negative Adjustable Voltage Regulator - High Performance			
SG137A	IG		7703406U(X)	Negative Adjustable Voltage Regulator - High Performance			
SG140-05	R			Positive Fixed Voltage Regulator			
SG140-05	K			Positive Fixed Voltage Regulator			
SG140-05	T			Positive Fixed Voltage Regulator			
SG140-05	L			Positive Fixed Voltage Regulator			
SG140-05	IG			Positive Fixed Voltage Regulator			
SG140-06	R			Positive Fixed Voltage Regulator			
SG140-06	K			Positive Fixed Voltage Regulator			
SG140-06	T			Positive Fixed Voltage Regulator			
SG140-06	L			Positive Fixed Voltage Regulator			
SG140-06	IG			Positive Fixed Voltage Regulator			
SG140-08	R			Positive Fixed Voltage Regulator			
SG140-08	K			Positive Fixed Voltage Regulator			
SG140-08	T			Positive Fixed Voltage Regulator			
SG140-08	L			Positive Fixed Voltage Regulator			
SG140-08	IG			Positive Fixed Voltage Regulator			
SG140-12	R			Positive Fixed Voltage Regulator			
SG140-12	K			Positive Fixed Voltage Regulator			
SG140-12	T			Positive Fixed Voltage Regulator			
SG140-12	L			Positive Fixed Voltage Regulator			
SG140-12	IG			Positive Fixed Voltage Regulator			
SG140-15	R			Positive Fixed Voltage Regulator			
SG140-15	K			Positive Fixed Voltage Regulator			
SG140-15	T			Positive Fixed Voltage Regulator			
SG140-15	L			Positive Fixed Voltage Regulator			
SG140-15	IG			Positive Fixed Voltage Regulator			
SG140-18	R			Positive Fixed Voltage Regulator			
SG140-18	К			Positive Fixed Voltage Regulator			
SG140-18	T		ET SCHOOL TO	Positive Fixed Voltage Regulator			
SG140-18	L			Positive Fixed Voltage Regulator			
SG140-18	IG		ST STEELS	Positive Fixed Voltage Regulator			
SG140-20	R		STREET, STREET	Positive Fixed Voltage Regulator			
SG140-20	K		such auditionis	Positive Fixed Voltage Regulator			
SG140-20	T			Positive Fixed Voltage Regulator			

Note 1: a. This number may be preceded by "5962-". b. (X) denotes unspecified lead finish.



### APPROVED QML/QPL LISTINGS

### All QML Products



Generic Pa	art #	MIL-M-38510	Standard MIL	
(/883B		Part No. (JAN)	Drawing (SMD)	Description
Part No.	Pkg.		(Note 1)	
SG140-20	L			Positive Fixed Voltage Regulator
SG140-20	IG			Positive Fixed Voltage Regulator
SG140-24	R			Positive Fixed Voltage Regulator
SG140-24	K			Positive Fixed Voltage Regulator
SG140-24	T			Positive Fixed Voltage Regulator
SG140-24	L			Positive Fixed Voltage Regulator
SG140-24	IG			Positive Fixed Voltage Regulator
SG140A-05	IG			Positive Fixed Voltage Regulator
G140A-06	IG			Positive Fixed Voltage Regulator
SG140A-08	IG			Positive Fixed Voltage Regulator
SG140A-12	IG			Positive Fixed Voltage Regulator
SG140A-15	IG			Positive Fixed Voltage Regulator
SG140A-18	IG			Positive Fixed Voltage Regulator
SG140A-20	IG			Positive Fixed Voltage Regulator
SG140A-24	IG			Positive Fixed Voltage Regulator
SG143	T		7800303Y(X)	High-Voltage Op-Amp
SG143	У		7800303P(X)	High-Voltage Op-Amp
SG723	T	10201BI(X)		Positive Adjustable Voltage Regulator
SG723	J	10201BC(X)		Positive Adjustable Voltage Regulator
SG723	F	10201BH(X)		Positive Adjustable Voltage Regulator
SG723	L			Positive Adjustable Voltage Regulator
SG1503	T		8686101Y(X)	Precision 2.5 Volt Reference
G1503	У		8686101P(X)	Precision 2.5 Volt Reference
SG1524	J	12601BE(X)	7802801E(X)	Regulating PWM
SG1524	L			Regulating PWM
SG1524B	J		8764501E(X)	Regulating PWM
SG1524B	L			Regulating PWM
SG1525A	J	12602BE(X)	8951101E(X)	Regulation PWM
SG1525A	L			Regulating PWM
SG1526	J			Regulating PWM
SG1526	L			Regulating PWM
SG1526B	J	12603BV(X)	8551501V(X)	Regulating PWM
SG1526B	L			Regulating PWM
SG1527A	J	12604BE(X)	8951102E(X)	Regulating PWM
SG1527A	L			Regulating PWM
SG1529	J			Voltage Mode Feed Forward PWM Controller
SG1532	T		8777001I(X)	High Precision Positive Adjustable Voltage Regulator
SG1532	J		8777001C(X)	High Precision Positive Adjustable Voltage Regulator
SG1532	L			High Precision Positive Adjustable Voltage Regulator
SG1536	T		7800304X(X)	High-Voltage Op-Amp
SG1536	У		7800304P(X)	High-Voltage Op-Amp

Note 1: a. This number may be preceded by "5962-".
b. (X) denotes unspecified lead finish.



### APPROVED QML/QPL LISTINGS

All QML Products



(continued)							
Generic P (/883B		MIL-M-38510 Part No. (JAN)	Standard MIL Drawing (SMD)	Description			
Part No.	Pkg.		(Note 1)				
SG1540	У			Off-Line Start-Up Controller			
SG1543	J		8774001E(X)	Precision Voltage Supervisor			
SG1543	L			Precision Voltage Supervisor			
SG1544	J		8774002V(X)	Precision Voltage Supervisor			
SG1548	J		8987801E(X)	Quad Fault Monitor			
SG1548	L			Quad Fault Monitor			
SG1549	У		8684901P(X)	Current Sense Latch			
SG1626	У		8871601P(X)	Hi-Speed MOSFET Dual Driver, Inverting			
SG1626	J		8871601C(X)	Hi-Speed MOSFET Dual Driver, Inverting			
SG1626	T		8871601G(X)	Hi-Speed MOSFET Dual Driver, Inverting			
SG1626	R		8871601X(X)	Hi-Speed MOSFET Dual Driver, Inverting			
SG1626	L			Hi-Speed MOSFET Dual Driver, Inverting			
SG1635	R			Half-Bridge Driver			
SG1644	У		9165301MP(X)	Hi-Speed MOSFET Dual Driver, Non-Inverting			
SG1644	J		9165301MC(X)	Hi-Speed MOSFET Dual Driver, Non-Inverting			
SG1644	T		9165301MG(X)	Hi-Speed MOSFET Dual Driver, Non-Inverting			
SG1644	R			Hi-Speed MOSFET Dual Driver, Non-Inverting			
SG1644	L		9165301M2(X)	Hi-Speed MOSFET Dual Driver, Non-Inverting			
SG1731	J			DC Motor PWM			
SG1731	L			DC Motor PWM			
LX1823M	J			High-Speed Current Mode PWM			
SG1825C	J		8768101E(X)	High-Speed Current Mode PWM			
SG1825C	L		87681012(X)	High-Speed Current Mode PWM			
SG1842	У		8670401P(X)	Current-Mode PWM Controller			
SG1842	J		8670401E(X)	Current-Mode PWM Controller			
SG1842	F		8670401H(X)	Current-Mode PWM Controller			
SG1842	L		86704012(X)	Current-Mode PWM Controller			
SG1843	У		8670402P(X)	Current-Mode PWM Controller			
SG1843	J		8670402C(X)	Current-Mode PWM Controller			
SG1843	F		8670402H(X)	Current-Mode PWM Controller			
SG1843	L		86704022(X)	Current-Mode PWM Controller			
SG1844	У		8670403P(X)	Current Mode PWM Controller			
SG1844	J		8670403E(X)	Current Mode PWM Controller			
SG1844	F		8670403H(X)	Current Mode PWM Controller			
SG1844	L		86704032(X)	Current Mode PWM Controller			
SG1844	L		86704032(X)	Current Mode PWM Controller			
SG1844	L		86704032(X)	Current Mode PWM Controller			
SG1845	У		8670404P(X)	Current Mode PWM Controller			
SG1845	J		8670404E(X)	Current Mode PWM Controller			
SG1845	F		8670404H(X)	Current Mode PWM Controller			
SG1845	L		86704042(X)	Current Mode PWM Controller			

Note 1: a. This number may be preceded by "5962-". b. (X) denotes unspecified lead finish.



### APPROVED QML/QPL LISTINGS

All QML Products



(continued)							
Generic I (/883		MIL-M-38510 Part No. (JAN)	Standard MIL Drawing (SMD)	Description			
Part No.	Pkg.		(Note 1)				
SG1846	J		8680601E(X)	Current-Mode PWM			
SG1846	F		8680601F(X)	Current-Mode PWM			
SG1846	L		86806012(X)	Current-Mode PWM			
SG2001	J	14101BE(X)		Hi-Voltage, Medium Current Driver Array			
SG2001	L			Hi-Voltage, Medium Current Driver Array			
SG2002	J	14102BE(X)		Hi-Voltage, Medium Current Driver Array			
SG2002	L			Hi-Voltage, Medium Current Driver Array			
SG2003	J	14103BE(X)		Hi-Voltage, Medium Current Driver Array			
SG2003	L			Hi-Voltage, Medium Current Driver Array			
SG2004	J	14104BE(X)		Hi-Voltage, Medium Current Driver Array			
SG2004	L			Hi-Voltage, Medium Current Driver Array			
SG2011	J			Hi-Voltage, Medium Current Driver Array			
SG2011	L			Hi-Voltage, Medium Current Driver Array			
SG2012	JV			Hi-Voltage, Medium Current Driver Array			
SG2012	L			Hi-Voltage, Medium Current Driver Array			
SG2013	J			Hi-Voltage, Medium Current Driver Array			
SG2013	L			Hi-Voltage, Medium Current Driver Array			
SG2014	J			Hi-Voltage, Medium Current Driver Array			
SG2014	L			Hi-Voltage, Medium Current Driver Array			
SG2021	J			Hi-Voltage, Medium Current Driver Array			
SG2021	L			Hi-Voltage, Medium Current Driver Array			
SG2022	J			Hi-Voltage, Medium Current Driver Array			
SG2022	L			Hi-Voltage, Medium Current Driver Array			
SG2023	J		8987601E(X)	Hi-Voltage, Medium Current Driver Array			
SG2023	L			Hi-Voltage, Medium Current Driver Array			
SG2024	JV			Hi-Voltage, Medium Current Driver Array			
SG2024	L			Hi-Voltage, Medium Current Driver Array			
SG2074	JV			Quad 1.5A Darlington Switches			
SG2801	J	14106BV(X)		Hi-Voltage, Medium Current Driver Array			
SG2801	L			Hi-Voltage, Medium Current Driver Array			
SG2802	J	14107BV(X)		Hi-Voltage, Medium Current Driver Array			
SG2802	L			Hi-Voltage, Medium Current Driver Array			
SG2803	J	14108BV(X)	8605801V(X)	Hi-Voltage, Medium Current Driver Array			
SG2803	L V8		86058012(X)	Hi-Voltage, Medium Current Driver Array			
SG2804	J	14109BV(X)		Hi-Voltage, Medium Current Driver Array			
SG2804	LVE			Hi-Voltage, Medium Current Driver Array			
SG2811	J			Hi-Voltage, Medium Current Driver Array			
SG2811	L V8			Hi-Voltage, Medium Current Driver Array			
SG2812	J			Hi-Voltage, Medium Current Driver Array			
SG2812	L			Hi-Voltage, Medium Current Driver Array			
SG2813	J			Hi-Voltage, Medium Current Driver Array			

Note 1: a. This number may be preceded by "5962-". b. (X) denotes unspecified lead finish.



### APPROVED QML/QPL LISTINGS

All QML Products



(continued)							
Generic F (/883)	SECTION AND DESCRIPTION OF THE PERSON NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TWO IS	MIL-M-38510 Part No. (JAN)	Standard MIL Drawing (SMD)	Description			
Part No.	Pkg.		(Note 1)				
SG2813	L			Hi-Voltage, Medium Current Driver Array			
SG2814	J			Hi-Voltage, Medium Current Driver Array			
SG2814	L			Hi-Voltage, Medium Current Driver Array			
SG2821	J		8968401V(X)	Hi-Voltage, Medium Current Driver Array			
SG2821	L		89684012(X)	Hi-Voltage, Medium Current Driver Array			
SG2822	J			Hi-Voltage, Medium Current Driver Array			
SG2822	L			Hi-Voltage, Medium Current Driver Array			
SG2823	J		8968501V(X)	Hi-Voltage, Medium Current Driver Array			
SG2823	L		89685012(X)	Hi-Voltage, Medium Current Driver Array			
SG2824	J		8968601V(X)	Hi-Voltage, Medium Current Driver Array			
SG2824	L		89686012(X)	Hi-Voltage, Medium Current Driver Array			
SG3081	J		8866401E(X)	Transistor Array			
SG7805	K	10706BY(X)		Positive Fixed Voltage Regulator - 5V			
SG7805	R	A SHAND SHORE O HIGH		Positive Fixed Voltage Regulator - 5V			
SG7805	T	10702BX(X)		Positive Fixed Voltage Regulator - 5V			
SG7805	IG	A Service section contribution		Positive Fixed Voltage Regulator - 5V			
SG7805A	L		88746012(X)	Positive Fixed Voltage Regulator - 5V			
SG7805A	K		8778201Y(X)	Positive Fixed Voltage Regulator - 5V			
SG7805A	R		8778201Z(X)	Positive Fixed Voltage Regulator - 5V			
SG7805A	T		8778201X(X)	Positive Fixed Voltage Regulator - 5V			
SG7805A	IG		8778201U(X)	Positive Fixed Voltage Regulator - 5V			
SG7805A	L		87782012(X)	Positive Fixed Voltage Regulator - 5V			
SG7806	K			Positive Fixed Voltage Regulator - 6V			
SG7806	R			Positive Fixed Voltage Regulator - 6V			
SG7806	T			Positive Fixed Voltage Regulator - 6V			
SG7806	IG			Positive Fixed Voltage Regulator - 6V			
SG7806	L			Positive Fixed Voltage Regulator - 6V			
SG7806A	K		8962601Y(X)	Positive Fixed Voltage Regulator - 6V			
SG7806A	R		8962601Z(X)	Positive Fixed Voltage Regulator - 6V			
SG7806A	T		8962601X(X)	Positive Fixed Voltage Regulator - 6V			
SG7806A	IG			Positive Fixed Voltage Regulator - 6V			
SG7808	K	A isotto saudo i sono	SM SMITHS SELECTION	Positive Fixed Voltage Regulator - 8V			
SG7808	R			Positive Fixed Voltage Regulator - 8V			
SG7808	T		SAL SSOSISION CONTRACTOR	Positive Fixed Voltage Regulator - 8V			
SG7808	IG			Positive Fixed Voltage Regulator - 8V			
SG7808	L		SIA SECTION H	Positive Fixed Voltage Regulator - 8V			
SG7808A	K		8962801Y(X)	Positive Fixed Voltage Regulator - 8V			
SG7808A	R		8962801Z(X)	Positive Fixed Voltage Regulator - 8V			
SG7808A	T		8962801X(X)	Positive Fixed Voltage Regulator - 8V			
SG7808A	IG			Positive Fixed Voltage Regulator - 8V			
SG7812	K	10707BY(X)		Positive Fixed Voltage Regulator - 12V			

Note 1: a. This number may be preceded by "5962-".
b. (X) denotes unspecified lead finish.

enotes unspecified lead finish. (continued next page)



### APPROVED QML/QPL LISTINGS

All QML Products



(continued)							
Generic (/883		MIL-M-38510 Part No. (JAN)	Standard MIL Drawing (SMD)	Description			
Part No.	Pkg.		(Note 1)				
SG7812	R			Positive Fixed Voltage Regulator - 12V			
SG7812	T	10703BX(X)		Positive Fixed Voltage Regulator - 12V			
SG7812	IG			Positive Fixed Voltage Regulator - 12V			
SG7812	LVAG			Positive Fixed Voltage Regulator - 12V			
SG7812A	K		8777601Y(X)	Positive Fixed Voltage Regulator - 12V			
SG7812A	R		8777601Z(X)	Positive Fixed Voltage Regulator - 12V			
SG7812A	T		8777601X(X)	Positive Fixed Voltage Regulator - 12V			
SG7812A	IG		8777601U(X)	Positive Fixed Voltage Regulator - 12V			
SG7812A	L		87776012(X)	Positive Fixed Voltage Regulator - 12V			
SG7815	K	10708BY(X)		Positive Fixed Voltage Regulator - 15V			
SG7815	R			Positive Fixed Voltage Regulator - 15V			
SG7815	T	10704BX(X)		Positive Fixed Voltage Regulator - 15V			
SG7815	IG			Positive Fixed Voltage Regulator - 15V			
SG7815	L			Positive Fixed Voltage Regulator - 15V			
SG7815A	K		8855301Y(X)	Positive Fixed Voltage Regulator - 15V			
SG7815A	R		8855301Z(X)	Positive Fixed Voltage Regulator - 15V			
SG7815A	T		8855301X(X)	Positive Fixed Voltage Regulator - 15V			
SG7815A	IG		8855301U(X)	Positive Fixed Voltage Regulator - 15V			
SG7815A	L		88553012(X)	Positive Fixed Voltage Regulator - 15V			
SG7818	K			Positive Fixed Voltage Regulator - 18V			
SG7818	R			Positive Fixed Voltage Regulator - 18V			
SG7818	T			Positive Fixed Voltage Regulator - 18V			
SG7818	IG			Positive Fixed Voltage Regulator - 18V			
SG7818	L			Positive Fixed Voltage Regulator - 18V			
SG7818A	K			Positive Fixed Voltage Regulator - 18V			
SG7818A	R			Positive Fixed Voltage Regulator - 18V			
SG7818A	T			Positive Fixed Voltage Regulator - 18V			
SG7818A	IG			Positive Fixed Voltage Regulator - 18V			
SG7820	K			Positive Fixed Voltage Regulator - 20V			
SG7820	R			Positive Fixed Voltage Regulator - 20V			
SG7820	T			Positive Fixed Voltage Regulator - 20V			
SG7820	IG			Positive Fixed Voltage Regulator - 20V			
SG7820	L						
SG7820A	K		9152301Y(X)				
SG7820A	R		9152301Z(X)				
SG7820A	T		9152301X(X)				
SG7820A	IG		9152301U(X)				
SG7824A	K	Combada spelat	Sales Services (4				
SG7824	K						
SG7824	R		GART STOLES AT THE	Positive Fixed Voltage Regulator - 24V			
SG7824	T		BOAT OF STREET, STREET				
SG7820 SG7820A SG7820A SG7820A SG7820A SG7824A SG7824 SG7824	L K R T IG K K		9152301Z(X) 9152301X(X)	Positive Fixed Voltage Regulator - 20V Positive Fixed Voltage Regulator - 24V			

Note 1: a. This number may be preceded by "5962-". b. (X) denotes unspecified lead finish.



### APPROVED QML/QPL LISTINGS

All QML Products



(continued)							
Generic P (/883B	CONTRACTOR DESCRIPTION OF THE PERSON OF THE	MIL-M-38510 Part No. (JAN)	Standard MIL Drawing (SMD)	Description			
Part No.	Pkg.		(Note 1)		Late Held		
SG7824	IG			Positive Fixed Voltage Regulator - 24V			
SG7824	L			Positive Fixed Voltage Regulator - 24V			
SG7824A	K		8855401Y(X)	Positive Fixed Voltage Regulator - 24V			
SG7824A	R		8855401Z(X)	Positive Fixed Voltage Regulator - 24V			
SG7824A	T		8855401X(X)	Positive Fixed Voltage Regulator - 24V			
SG7824A	IG			Positive Fixed Voltage Regulator - 24V			
SG7905	K	11505BY(X)		Negative Fixed Voltage Regulator - 5V			
SG7905	R			Negative Fixed Voltage Regulator - 5V			
SG7905	T	11501BX(X)		Negative Fixed Voltage Regulator - 5V			
SG7905	IG			Negative Fixed Voltage Regulator - 5V			
SG7905	L			Negative Fixed Voltage Regulator - 5V			
SG7905A	K		8874601Y(X)	Negative Fixed Voltage Regulator - 5V			
SG7905A	R		8874601Z(X)	Negative Fixed Voltage Regulator - 5V			
SG7905A	T		8874601X(X)	Negative Fixed Voltage Regulator - 5V			
SG7905A	IG		8874601U(X)	Negative Fixed Voltage Regulator - 5V			
SG7905.2	K			Negative Fixed Voltage Regulator - 5.2V			
SG7905.2	R			Negative Fixed Voltage Regulator - 5.2V			
SG7905.2	T			Negative Fixed Voltage Regulator - 5.2V			
SG7905.2	IG			Negative Fixed Voltage Regulator - 5.2V			
SG7905.2	L			Negative Fixed Voltage Regulator - 5.2V			
SG7905.2A	K			Negative Fixed Voltage Regulator - 5.2V			
SG7905.2A	R			Negative Fixed Voltage Regulator - 5.2V			
SG7905.2A	T			Negative Fixed Voltage Regulator - 5.2V			
SG7905.2A	IG			Negative Fixed Voltage Regulator - 5.2V			
SG7908	K			Negative Fixed Voltage Regulator - 8V			
SG7908	R			Negative Fixed Voltage Regulator - 8V			
SG7908	T			Negative Fixed Voltage Regulator - 8V			
SG7908	IG			Negative Fixed Voltage Regulator - 8V			
SG7908	L			Negative Fixed Voltage Regulator - 8V			
SG7908A	K		8987001Y(X)	Negative Fixed Voltage Regulator - 8V			
SG7908A	R		8987001Z(X)	Negative Fixed Voltage Regulator - 8V			
SG7908A	T		8987001X(X)	Negative Fixed Voltage Regulator - 8V			
SG7908A	IG		8987001U(X)	Negative Fixed Voltage Regulator - 8V			
SG7912	K	11506BY(X)		Negative Fixed Voltage Regulator - 12V			
SG7912	R			Negative Fixed Voltage Regulator - 12V			
SG7912	T	11502BX(X)		Negative Fixed Voltage Regulator - 12V			
SG7912	IG			Negative Fixed Voltage Regulator - 12V			
SG7912	L			Negative Fixed Voltage Regulator - 12V			
SG7912A	K		8874701Y(X)	Negative Fixed Voltage Regulator - 12V			
SG7912A	R		8874701Z(X)	Negative Fixed Voltage Regulator - 12V			
SG7912A	T		8874701X(X)	Negative Fixed Voltage Regulator - 12V			

Note 1: a. This number may be preceded by "5962-". b. (X) denotes unspecified lead finish.



### APPROVED QML/QPL LISTINGS

All QML Products



Generic Part # (/883B)		MIL-M-38510 Part No. (JAN)	Standard MIL Drawing (SMD)	Description
Part No.	Pkg.	Tarrior (Brain)	(Note 1)	
SG7912A	IG		8874701U(X)	Negative Fixed Voltage Regulator - 12V
G7915	K	11507BY(X)		Negative Fixed Voltage Regulator - 15V
SG7915	R	1,100,757(17)		Negative Fixed Voltage Regulator - 15V
SG7915	T	11503BX(X)		Negative Fixed Voltage Regulator - 15V
SG7915	IG			Negative Fixed Voltage Regulator - 15V
G7915	L			Negative Fixed Voltage Regulator - 15V
SG7915A	K		8874801Y(X)	Negative Fixed Voltage Regulator - 15V
G7915A	R		8874801Z(X)	Negative Fixed Voltage Regulator - 15V
G7915A	T		8874801X(X)	Negative Fixed Voltage Regulator - 15V
G7915A	IG		8874801U(X)	Negative Fixed Voltage Regulator - 15V
G7918	K			Negative Fixed Voltage Regulator - 18V
SG7918	R			Negative Fixed Voltage Regulator - 18V
G7918	T			Negative Fixed Voltage Regulator - 18V
G7918	IG		Market Market	Negative Fixed Voltage Regulator - 18V
G7918	L			Negative Fixed Voltage Regulator - 18V
SG7918A	K			Negative Fixed Voltage Regulator - 18V
G7918A	R			Negative Fixed Voltage Regulator - 18V
G7918A	T			Negative Fixed Voltage Regulator - 18V
G7918A	IG			Negative Fixed Voltage Regulator - 18V
G7920	K			Negative Fixed Voltage Regulator - 20V
G7920	R			Negative Fixed Voltage Regulator - 20V
SG7920	Т			Negative Fixed Voltage Regulator - 20V
SG7920	IG			Negative Fixed Voltage Regulator - 20V
G7920	L			Negative Fixed Voltage Regulator - 20V
6G7920A	K			Negative Fixed Voltage Regulator - 20V
G7920A	R			Negative Fixed Voltage Regulator - 20V
G7920A	T			Negative Fixed Voltage Regulator - 20V
G7920A	IG			Negative Fixed Voltage Regulator - 20V
6G7924	K	11508BY(X)		Negative Fixed Voltage Regulator - 24V
SG55236	F			Undervoltage Sensing Circuit
G55325	F	13001BF(X)		Dual Source/Sink Memory Driver
SG55325	J	13001BE(X)		Dual Source/Sink Memory Driver
SG55325	L			Dual Source/Sink Memory Driver
G55326	F			Quad Core Memory Driver
G55326	J	13002BE(X)		Quad Core Memory Driver
G55326	L			Quad Core Memory Driver
SG55327	F			Quad Core Memory Driver
G55327	J			Quad Core Memory Driver
G55327	L			Quad Core Memory Driver
G55450B	J			Dual Peripheral Driver
SG55450B	L			Dual Peripheral Driver

Note 1: a. This number may be preceded by "5962-".
b. (X) denotes unspecified lead finish.



### APPROVED QML/QPL LISTINGS

All QML Products



Generic Part # (/883B)		MIL-M-38510 Part No. (JAN)	Standard MIL Drawing (SMD)	Description	
Part No.	Pkg.		(Note 1)		
SG55451B	У			Dual Peripheral Driver	
SG55451B	L			Dual Peripheral Driver	
SG55452B	У	12903BP(X)	7704901P(X)	Dual Peripheral Driver	
SG55452B	L		77049012(X)	Dual Peripheral Driver	
SG55453B	У			Dual Peripheral Driver	
SG55453B	L			Dual Peripheral Driver	
SG55454B	У			Dual Peripheral Driver	
SG55454B	L		88715012(X)	Dual Peripheral Driver	
SG55460	J			Dual Peripheral Driver	
SG55460	L			Dual Peripheral Driver	
SG55461	У			Dual Peripheral Driver	
SG55461	L			Dual Peripheral Driver	
SG55462	У			Dual Peripheral Driver	
SG55462	L			Dual Peripheral Driver	
SG55463	У			Dual Peripheral Driver	
SG55463	L			Dual Peripheral Driver	
SG55464	У		8871502P(X)	Dual Peripheral Driver	
SG55464	L		88715022(X)	Dual Peripheral Driver	
SG55470	J			Dual Peripheral Driver	
SG55470	L			Dual Peripheral Driver	
SG55471	У			Dual Peripheral Driver	
SG55471	L			Dual Peripheral Driver	
SG55472	У			Dual Peripheral Driver	
SG55472	L			Dual Peripheral Driver	
SG55473	У			Dual Peripheral Driver	
SG55473	L			Dual Peripheral Driver	
SG55474	У		8871503P(X)	Dual Peripheral Driver	
SG55474	L		88715032(X)	Dual Peripheral Driver	

Note 1: a. This number may be preceded by "5962-". b. (X) denotes unspecified lead finish.

**End Cross Reference 1** 



### APPROVED QML/QPL LISTINGS

JAN Products



Listing of all MIL-M-38510 (JAN) Qualified products

MIL-M-38510 (JAN)	Generic Part #		Description			
(Note 1)	Part No.	Pkg.	pik Jakika (Paca)			
10201BC(X)	SG723	J	Positive Adjustable Voltage Regulator			
10201BH(X)	SG723	F	Positive Adjustable Voltage Regulator			
10201BI(X)	SG723	T	Positive Adjustable Voltage Regulator			
10701BX(X)	SG109	T	Positive Fixed Voltage Regulator			
10702BX(X)	SG7805	T	Positive Fixed Voltage Regulator - 5V			
10703BX(X)	SG7812	T	Positive Fixed Voltage Regulator - 12V			
10704BX(X)	SG7815	T	Positive Fixed Voltage Regulator - 15V			
10706BY(X)	SG7805	K	Positive Fixed Voltage Regulator - 5V			
10707BY(X)	SG7812	K	Positive Fixed Voltage Regulator - 12V			
10708BY(X)	SG7815	K	Positive Fixed Voltage Regulator - 15V			
11501BX(X)	SG7905	T	Negative Fixed Voltage Regulator - 5V			
11502BX(X)	SG7912	T	Negative Fixed Voltage Regulator - 12V			
11503BX(X)	SG7915	T	Negative Fixed Voltage Regulator - 15V			
11505BY(X)	SG7905	K	Negative Fixed Voltage Regulator - 5V			
11506BY(X)	SG7912	K	Negative Fixed Voltage Regulator - 12V			
11507BY(X)	SG7915	K	Negative Fixed Voltage Regulator - 15V			
11508BY(X)	SG7924	K	Negative Fixed Voltage Regulator - 24V			
11703BX(X)	SG117	T	Positive Adjustable Voltage Regulator			
11704BY(X)	SG117	K	Positive Adjustable Voltage Regulator			
11804BY(X)	SG137	K	Negative Fixed Voltage Regulator			
12601BE(X)	SG1524	J	Regulating PWM			
1260ΩBE(X)	SG1525A	J	Regulation PWM			
12603BV(X)	SG1526B	J	Regulating PWM			
12604BE(X)	SG1527A	J	Regulating PWM			
12903BP(X)	SG55452B	У	Dual Peripheral Driver			
13001BE(X)	SG55325	J	Dual Source/Sink Memory Driver			
13001BF(X)	SG55325	F	Dual Source/Sink Memory Driver			
13002BE(X)	SG55326	J	Quad Core Memory Driver			
14101BE(X)	SG2001	J	Hi-Voltage, Medium Current Driver Array			
14102BE(X)	SG2002	J	Hi-Voltage, Medium Current Driver Array			
14103BE(X)	SG2003	J	Hi-Voltage, Medium Current Driver Array			
14104BE(X)	SG2004	J	Hi-Voltage, Medium Current Driver Array			
14106BV(X)	SG2801	J	Hi-Voltage, Medium Current Driver Array			
14107BV(X)	SG2802	J	Hi-Voltage, Medium Current Driver Array			
14108BV(X)	SG2803	J	Hi-Voltage, Medium Current Driver Array			
14109BV(X)	SG2804	J	Hi-Voltage, Medium Current Driver Array			

Note 1: (X) denotes unspecified lead finish.

End Cross Reference 2



# **Military Products**

### APPROVED QML/QPL LISTINGS

SMD (DESC) Products



Listing of all Standard Military Drawing (SMD) Qualified products

Standard MIL Drawing (SMD)	Generic P		Description	
(Note 1)	Part No.	Pkg.	THE PARTY OF THE P	
7702801X(X)	SG103-1.8	Z	Voltage Reference 1.8V	
7702805X(X)	SG103-2.7	Z	Voltage Reference 2.7V	
7702811X(X)	SG103-4.7	Z	Voltage Reference 4.7V	
77034012(X)	SG117	L	Positive Adj. Voltage Regulator	
7703401U(X)	SG117	IG	Positive Adj. Voltage Regulator	
7703401X(X)	SG117	TVS	Positive Adj. Voltage Regulator	
7703401Y(X)	SG117	K	Positive Adj. Voltage Regulator	
7703401Z(X)	SG117	R	Positive Adj. Voltage Regulator	bits
77034032(X)	SG137	L	Neg. Fixed Voltage Regulator	500
7703403U(X)	SG137	IG	Neg. Fixed Voltage Regulator	
7703403X(X)	SG137	T	Neg. Fixed Voltage Regulator	1000
7703403Y(X)	SG137	K	Neg. Fixed Voltage Regulator	
7703403Z(X)	SG137	R	Neg. Fixed Voltage Regulator	
77034052(X)	SG117A	L	Positive Adjustable Voltage Regulator	
7703405U(X)	SG117A	IG	Positive Adjustable Voltage Regulator	
7703405X(X)	SG117A	T	Positive Adjustable Voltage Regulator	
7703405Y(X)	SG117A	K	Positive Adjustable Voltage Regulator	
7703405Z(X)	SG117A	R	Positive Adjustable Voltage Regulator	
77034062(X)	SG137A	L	Neg. Adj. Voltage Reg High Perf.	
7703406U(X)	SG137A	IG	Neg. Adj. Voltage Reg High Perf.	
7703406X(X)	SG137A	T	Neg. Adj. Voltage Reg High Perf.	
7703406Y(X)	SG137A	K	Neg. Adj. Voltage Reg High Perf.	
7703406Z(X)	SG137A	R	Neg. Adj. Voltage Reg High Perf.	
77049012(X)	SG55452B	L	Dual Peripheral Driver	
7704901P(X)	SG55452B	У	Dual Peripheral Driver	
7800303P(X)	SG143	У	High-Voltage Op-Amp	
7800303X(X)	SG143	T	High-Voltage Op-Amp	
7800304P(X)	SG1536	У	High-Voltage Op-Amp	
7800304X(X)	SG1536	T	High-Voltage Op-Amp	
7802801E(X)	SG1524	J	Regulating PWM	
3551501V(X)	SG1526B	J	Regulating PWM	
36058012(X)	SG2803	L	Hi-Voltage, Med. Curr. Driver Array	
3605801V(X)	SG2803	J	Hi-Voltage, Med. Curr. Driver Array	
36704012(X)	SG1842	L	Current-Mode PWM	
3670401C(X)	SG1842	J (14)	Current-Mode PWM	
3670401E(X)	SG1842	J (16)	Current-Mode PWM	523
3670401H(X)	SG1842	F	Current-Mode PWM	
3670401P(X)	SG1842	У	Current-Mode PWM	1019
36704022(X)	SG1843	L	Current-Mode PWM	
3670402C(X)	SG1843	J	Current-Mode PWM	
3670402H(X)	SG1843	F	Current-Mode PWM	

Note 1: a. This number may be preceded by "5962-".
b. (X) denotes unspecified lead finish.

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# **Military Products**

### APPROVED QML/QPL LISTINGS

SMD (DESC) Products



(continued)

Standard MIL Drawing (SMD)	Generic Part # (DESC)		Description		
(Note 1)	Part No.	Pkg.	Description		
8670402P(X)	SG1843	y y	Current-Mode PWM		
86704032(X)	SG1844	L	Current Mode PWM Controller		
86704032(X)	SG1844	J (14)	Current Mode PWM Controller		
8670403E(X)	SG1844	J (16)	Current Mode PWM Controller		
8670403E(X)	SG1844	F F	Current Mode PWM Controller		
8670403P(X)	SG1844	У	Current Mode PWM Controller		
8670403F(X)	SG1845	L	Current Mode PWM Controller  Current Mode PWM Controller		
86704042(X)	SG1845	J (14)	Current Mode PWM Controller		
8670404E(X)	SG1845	J (14)	Current Mode PWM Controller  Current Mode PWM Controller		
		and the second second	Current Mode PWM Controller		
8670404H(X)	SG1845	F			
8670404P(X)	SG1845	У	Current Mode PWM Controller		
86806012(X)	SG1846	L	Current-Mode PWM		
8680601E(X)	SG1846	J	Current-Mode PWM		
8680601F(X)	SG1846	F	Current-Mode PWM		
8684901P(X)	SG1549	У	Current Sense Latch		
3686101P(X)	SG1503	У	Precision 2.5 Volt Reference		
8686101Y(X)	SG1503	T	Precision 2.5 Volt Reference		
8764501E(X)	SG1524B	J	Regulating PWM		
37681012(X)	SG1825C	L	High-Speed Current Mode PWM		
8768101E(X)	SG1825C	J	High-Speed Current Mode PWM		
8774001E(X)	SG1543	J	Precision Voltage Supervisor		
8774002V(X)	SG1544	J	Precision Voltage Supervisor		
8777001C(X)	SG1532	J	High Precision Positive Adjustable Voltage Regulator		
8777001I(X)	SG1532	T	High Precision Positive Adjustable Voltage Regulator		
87776012(X)	SG7812A	L	Positive Fixed Voltage Regulator - 12V		
8777601U(X)	SG7812A	IG	Positive Fixed Voltage Regulator - 12V		
8777601X(X)	SG7812A	T	Positive Fixed Voltage Regulator - 12V		
8777601Y(X)	SG7812A	K	Positive Fixed Voltage Regulator - 12V		
8777601Z(X)	SG7812A	R	Positive Fixed Voltage Regulator - 12V		
87782012(X)	SG7805A	L	Positive Fixed Voltage Regulator - 5V		
8778201U(X)	SG7805A	IG	Positive Fixed Voltage Regulator - 5V		
8778201X(X)	SG7805A	T	Positive Fixed Voltage Regulator - 5V		
8778201Y(X)	SG7805A	K	Positive Fixed Voltage Regulator - 5V		
8778201Z(X)	SG7805A	R	Positive Fixed Voltage Regulator - 5V		
88553012(X)	SG7815A	L	Positive Fixed Voltage Regulator - 15V		
8855301U(X)	SG7815A	IG	Positive Fixed Voltage Regulator - 15V		
8855301X(X)	SG7815A	T	Positive Fixed Voltage Regulator - 15V		
8855301Y(X)	SG7815A	K	Positive Fixed Voltage Regulator - 15V		
8855301Z(X)	SG7815A	R	Positive Fixed Voltage Regulator - 15V		
8855401X(X)	SG7824A	T	Positive Fixed Voltage Regulator - 24V		
8855401Y(X)	SG7824A	K	Positive Fixed Voltage Regulator - 24V		

Note 1: a. This number may be preceded by "5962-". b. (X) denotes unspecified lead finish.

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### SMD (DESC) Products



Standard MIL Drawing (SMD)	Generic Part # (DESC)		Description		
(Note 1)	Part No.	Pkg.		Sed and the	43 (1969)
8855401Z(X)	SG7824A	R	Positive Fixed Voltage Regulator - 24V		
3866401E(X)	SG3081	J	Transistor Array		
88715012(X)	SG55454B	L	Dual Peripheral Driver		
38715022(X)	SG55464	L	Dual Peripheral Driver		
8871502P(X)	SG55464	У	Dual Peripheral Driver		
88715032(X)	SG55474	L	Dual Peripheral Driver		
8871503P(X)	SG55474	У	Dual Peripheral Driver		
8871601C(X)	SG1626	J	Hi-Speed MOSFET Dual Driver, Inverted		
8871601G(X)	SG1626	T	Hi-Speed MOSFET Dual Driver, Inverted		
8871601P(X)	SG1626	У	Hi-Speed MOSFET Dual Driver, Inverted		
8871601X(X)	SG1626	R	Hi-Speed MOSFET Dual Driver, Inverted		
88746012(X)	SG7905A	L	Negative Fixed Voltage Regulator - 5V		
8874601U(X)	SG7905A	IG	Negative Fixed Voltage Regulator - 5V		
8874601X(X)	SG7905A	T	Negative Fixed Voltage Regulator - 5V		
3874601Y(X)	SG7905A	K	Negative Fixed Voltage Regulator - 5V		
8874601Z(X)	SG7905A	R	Negative Fixed Voltage Regulator - 5V		
8874701U(X)	SG7912A	IG	Negative Fixed Voltage Regulator - 12V		
3874701X(X)	SG7912A	T	Negative Fixed Voltage Regulator - 12V		TELEVISION AT
8874701Y(X)	SG7912A	K	Negative Fixed Voltage Regulator - 12V		
8874701Z(X)	SG7912A	R	Negative Fixed Voltage Regulator - 12V	3818665	15 (5 (6 (3 to that
38748012(X)	SG7915A	L	Negative Fixed Voltage Regulator - 15V		
8874801U(X)	SG7915A	IG	Negative Fixed Voltage Regulator - 15V		DOM NO.
8874801X(X)	SG7915A	T	Negative Fixed Voltage Regulator - 15V		
8874801Y(X)	SG7915A	K	Negative Fixed Voltage Regulator - 15V		
3874801Z(X)	SG7915A	R	Negative Fixed Voltage Regulator - 15V		
8951101E(X)	SG1525A	J	Regulation PWM		
8951102E(X)	SG1527A	J	Regulating PWM		
8962601X(X)	SG7806A	T	Positive Fixed Voltage Regulator - 6V		
8962601Y(X)	SG7806A	K	Positive Fixed Voltage Regulator - 6V		
8962601Z(X)	SG7806A	R	Positive Fixed Voltage Regulator - 6V		
8962801X(X)	SG7808A	T	Positive Fixed Voltage Regulator - 8V		
8962801Y(X)	SG7808A	K	Positive Fixed Voltage Regulator - 8V		C38()X1023UE
8962801Z(X)	SG7808A	R	Positive Fixed Voltage Regulator - 8V		
89684012(X)	SG2821	L	Hi-Voltage, Medium Current Driver Array	Accertos.	T 88304 C 155 01284 T
8968401V(X)	SG2821	J	Hi-Voltage, Medium Current Driver Array		
89685012(X)	SG2823	L	Hi-Voltage, Medium Current Driver Array	ASTRICE.	855 sorutos 838
8968501V(X)	SG2823	J	Hi-Voltage, Medium Current Driver Array		NOTE OF THE PARTY
89686012(X)	SG2824	L	Hi-Voltage, Medium Current Driver Array	AETOTOE	SERVINGA A
8968601V(X)	SG2824	J	Hi-Voltage, Medium Current Driver Array	TO SERVICE SERVICE	
3987001U(X)	SG7908A	IG	Negative Fixed Voltage Regulator - 8V	ANDRESS 1	S STORY TO SER
8987001X(X)	SG7908A	T	Negative Fixed Voltage Regulator - 8V		TOTAL PROPERTY AND ADDRESS OF

Note 1: a. This number may be preceded by "5962-".
b. (X) denotes unspecified lead finish.

(continued next page)



## **Military Products**

### APPROVED QML/QPL LISTINGS

SMD (DESC) Products/QPL Products



Standard MIL Drawing (SMD)	Generic Part # (DESC) Part No.		Description		
(Note 1)			Pkg.		
8987001Y(X)	SG7908A	K	Negative Fixed Voltage Regulator - 8V		
8987001Z(X)	SG7908A	R	Negative Fixed Voltage Regulator - 8V		
8987601E(X)	SG2023	J	Hi-Voltage, Medium Current Driver Array		
8987801E(X)	SG1548	J	Quad Fault Monitor		
9152301U(X)	SG7820A	IG	Positive Fixed Voltage Regulator - 20V		
9152301X(X)	SG7820A	T	Positive Fixed Voltage Regulator - 20V		
9152301Y(X)	SG7820A	K	Positive Fixed Voltage Regulator - 20V		
9152301Z(X)	SG7820A	R	Positive Fixed Voltage Regulator - 20V		
9165301M2(X)	SG1644	J	High-Speed MOSFET Dual Driver, Non-Inverted		
9165301MC(X)	SG1644	T	High-Speed MOSFET Dual Driver, Non-Inverted		
9165301MG(X)	SG1644	Y	High-Speed MOSFET Dual Driver, Non-Inverted		
9165301MP(X)	SG1644	L	High-Speed MOSFET Dual Driver, Non-Inverted		
9669901ME(X)	SG1731	J	DC Motor Pulse Width Modulator		

#### **End Cross Reference 3**

#### QPL MILITARY PRODUCTS - MIL-S-19500

LINFINITY Microelectronics Inc offers a line of Diode Arrays which are manufacturered in compliance with MIL-S-19500/474 and processed to JANTXV, JANTX, and JAN specification levels. These devices are listed in the QPL-19500.

# Cross Reference MIL-S-19500 Qualifications (QPL)

Process Levels	Part # Pkg.	Description
J, JTX, JTXV	1N5768 F	8 Common Cathode Diode Array
J, JTX, JTXV	1N5770 F	8 Common Anode Diode Array
J, JTX, JTXV	1N5772 F	16 Diode Array
J, JTX, JTXV	1N5774 F	Dual 4 Common Anode, 4 Common Cathode
J, JTX, JTXV	1N6100 F	7 Straight Thru Diodes
J, JTX, JTXV	1N6101 J	8 Straight Thru Diodes
J, JTX, JTXV	1N6506 J	8 Common Cathode Diode Array
J, JTX, JTXV	1N6507 J	8 Common Anode Diode Array
J, JTX, JTXV	1N6508 J	16 Diode Array
J, JTX, JTXV	1N6509 J	Dual 4 Common Anode, 4 Common Cathode
J, JTX, JTXV	1N6510 F	8 Straight Thru Diodes
J, JTX, JTXV	1N6511 J	7 Straight Thru Diodes



Notes

1MD (DISC) Products/GPL Products

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### **Discontinued Products**

NOT RECOMMENDED FOR NEW DESIGNS,
LIFETIME BUY AND OBSOLETE PRODUCTS

#### DESCRIPTION OF LISTINGS

#### **General Information**

As part of Linfinity's continuous effort to improve availability and lead times on products, we monitor each product's demand over time. If demand is weak on older products which are no longer being designed into systems, they are candidates for obsolescence. We understand this can cause problems for low-volume or spare parts types of usage. Consequently, it is our policy to notify users in advance of a product's potential obsolescence and clissify that product as

(1) Not Recommended for New Designs, (2) a Lifetime Buy Product or (3) an Obsolete Product. Each of these categories is described below, followed by a table of Linfinity products which fall into the appropriate category at the time of the printing of this Databook. NOTE: Because products on each of these lists are constantly changing, users are urged to contact Linfinity for the most up-to-date information on a product's status.

### Table 1 -----→ Not Recommended for New Designs

A product that is initially targeted for obsolescence is first categorized as *Not Recommended for New Designs* to alert designers that it should not be used in new product designs. The typical life-span of a product in this category is six (6) months. During this *Not Recommended for New Designs* period, Linfinity will accept all orders, but will urge users to avoid this product for designs under development. Once this 6-month period ends, a product will typically be moved into

the *Lifetime Buy* category. Those products identified as candidates for the *Not Recommended for New Designs* status are candidates for obsolescence and may not necessarily be obsolete. Please contact Linfinity at the number listed below if you feel a particular product should not be made obsolete or if you need assistance finding a replacement product. Table 1 below lists products categorized as *Not Recommended for New Designs* at the time of this Databook's printing.

#### Table 2 ----- Lifetime Buy Products

Products listed in the *Lifetime Buy* category are defined as products that are within 6 months of obsolescence. During this *Lifetime Buy* period, Linfinity will accept all orders, but the product is non-returnable. Once this 6-month period expires, Linfinity will not accept orders for these products

unless inventory is available. Please contact Linfinity at the number listed below to place an order or to receive assistance in finding a replacement product. Table 2 below lists product in the *Lifetime Buy* category.

### Table 3 ----- Obsolete Products

Products listed in the Obsolete category are no longer being manufactured by Linfinity. Orders are no longer accepted on these products. However, in some instances, Linfinity may have inventory available. In these isolated cases, we will accept orders but the product is non-returnable. Please contact us at the number listed below to check inventory on obsoleted products or if you need assistance in finding a replacement product. (See Table 3)

More Info... For information on Lifetime Buys or Obsolete Products, please follow these instructions:

- 1. Call 714-898-8121.
- 2. Identify your call as a Discontinued Product Question
- 3. Please provide your Company name and Location.
- 4. The receptionist will forward your call to the appropriate Inside Sales Contact.

#### Table 1

#### NOT RECOMMENDED FOR NEW DESIGNS

	INOT RECOMMENDE	GNS	
Part No.	Description	Part No.	Description
LX1823	High-Speed Current-Mode PWM	SG55470/1/2/3/4	Dual Peripheral Positive Drivers
SG103-xx	Voltage Reference 1.8V - 5.1V	SM600/1/2/10/11/12	Switching Regulator Power Output Stages
SG120-xx	Neg. Fixed Voltage Reg 5.2,8,18,20,24V	SM625/626/627	Switching Regulator Power Output Stages
SG143/343	High Voltage Operational Amplifier	SM645/646/647	Switching Regulator Power Output Stages
SG140/A-xx	Pos. Fixed Voltage Reg 6,8,18,20,24V	SG75450B/1/2/3/4	Dual Peripheral Positive Drivers
SG1529/2529/3529	Voltage Mode Pulse Width Modulator	SG75460/1/2/3/4	Dual Peripheral Positive Drivers
SG1536/1436	High Voltage Operational Amplifier	SG75470/1/2/3/4	Dual Peripheral Positive Drivers
SG1540/2540/3540	Off-Line Start-Up Controller	SG7806/A	Positive Fixed Voltage Regulator - 6V
SG1635/3635	2A Half Bridge Driver	SG7808/A	Positive Fixed Voltage Regulator - 8V
SG1825C/2825C/3825C	High-Speed Current-Mode PWM	SG7818/A	Positive Fixed Voltage Regulator - 18V
SG3561A	Power Factor Contoller	SG7820/A	Positive Fixed Voltage Regulator - 20V
SG3645	Quad 2.5A Power Driver	SG7824/A	Positive Fixed Voltage Regulator - 24V
SG55236	Dual Sense Amplifier / Data Registers	SG7905.2/A	Negative Fixed Voltage Regulator - 5.2V
SG55325/75325	Dual Source / Dual Sink Memory Driver	SG7908/A	Negative Fixed Voltage Regulator - 8V
SG55326/74326	Quad Sink Memory Driver	SG7918/A	Negative Fixed Voltage Regulator - 18V
SG55327/75327	Quad Source Memory Driver	SG7920/A	Negative Fixed Voltage Regulator - 20V
SG55450B/1/2/3/4	Dual Peripheral Positive Drivers	SG7924/A	Negative Fixed Voltage Regulator - 24V
SG55460/1/2/3/4	Dual Peripheral Positive Drivers		



# **Discontinued Products**

### NOT RECOMMENDED FOR NEW DESIGNS, LIFETIME BUY AND OBSOLETE PRODUCTS

#### Table 2

#### LIFETIME BUY REFERENCE

Part No.	Description	Planned Obsol. Date
SG103-xx	Voltage Reference	10-95
SG1540	Off-Line Start-Up Controller	10-95
SG3645	Quad 2.5A Power Driver	10-95

#### Table 3

### OBSOLETE PRODUCT REFERENCE

Part No.	Date Obsolete	Part No.	Date Obsolete	Part No.	Date Obsolete	Part No.	Date Obsolete	Part No.	Date Obsolete
SG040	5/28/92	SG1568	5/28/92	SG238A	5/28/92	SG338	5/28/92	SG5524	5/28/92
SG101	5/28/92	SG1595	5/28/92	SG2401	5/28/92	SG338A	5/28/92	SG5534	5/28/92
SG101A	5/28/92	SG1596	5/28/92	SG2402	5/28/92	SG340	5/28/92	SG5768A	5/28/92
SG103-2.0	2/22/96	SG1627	5/28/92	SG250	5/28/92	SG3401	5/28/92	SG5770A	5/28/92
SG103-2.2	2/22/96	SG1629	5/28/92	SG2501A	5/28/92	SG3402	5/28/92	SG5772A	5/28/92
SG103-3.0	2/22/96	SG1635A	5/28/92	SG2502	5/28/92	SG3423	5/28/92	SG5774A	5/28/92
SG103-3.6	2/22/96	SG1650	5/28/92	SG250A	5/28/92	SG3423A	5/28/92	SG5792	5/28/92
SG103-3.9	2/22/96	SG1825	8/17/93	SG2528	5/28/92	SG343	10/1/94	SG5793	5/28/92
SG103-4.3	2/22/96	SG1840	5/28/92	SG2530	5/28/92	SG350	5/28/92	SM635	8/17/93
SG103-5.6	2/22/96	SG1847	5/28/92	SG2542	5/28/92	SG3501A	5/28/92	SM636	8/17/93
SG104	5/28/92	SG203	10/1/94	SG2557	5/28/92	SG3502	5/28/92	SM637	8/17/93
SG105	5/28/92	SG204	5/28/92	SG2559	11/15/95	SG350A	5/28/92	SM655	8/17/93
SG105A	5/28/92	SG205	5/28/92	SG2560	11/15/95	SG3523	5/28/92	SM656	8/17/93
SG107	5/28/92	SG205A	5/28/92	SG25768	5/28/92	SG3523A	5/28/92	SM657	8/17/93
SG111	5/28/92	SG2005	5/28/92	SG25770	5/28/92	SG3528	5/28/92	SM660	8/17/93
SG1173	8/17/93	SG2022	5/28/92	SG2805	10/1/94	SG3530	5/28/92	SM661	8/17/93
SG117AHV	5/28/92	SG2025	5/28/92	SG2822	10/1/94	SG3542	5/28/92	SM662	8/17/93
SG117HV	5/28/92	SG2064	5/28/92	SG2825	10/1/94	SG3557	5/28/92	SM670	8/17/93
SG124	5/28/92	SG2065	5/28/92	SG2840	5/28/92	SG3559	11/15/95	SM671	8/17/93
SG124A	5/28/92	SG2066	5/28/92	SG2847	5/28/92	SG3560	11/15/95	SM672	8/17/93
SG138	5/28/92	SG2067	5/28/92	SG301	5/28/92	SG3561	8/17/93	SG723C	5/28/92
SG138A	5/28/92	SG2068	5/28/92	SG301A	5/28/92	SG3627	5/28/92	SG741	5/28/92
SG1401	5/28/92	SG2069	5/28/92	SG303	10/1/94	SG3629	5/28/92	SG741C	5/28/92
SG1402	5/28/92	SG207	5/28/92	SG304	5/28/92	SG3635A	5/28/92	SG7805C	5/28/92
SG1468	5/28/92	SG2070	5/28/92	SG3045	5/28/92	SG3650	5/28/92	SG7806C	5/28/92
SG1488	5/28/92	SG2071	5/28/92	SG3046	5/28/92	SG3663	5/28/92	SG7808C	5/28/92
SG1489	5/28/92	SG2074	10/1/94	SG3049	5/28/92	SG3700	5/28/92	SG7812C	5/28/92
SG1489A	5/28/92	SG2075	10/1/94	SG305	5/28/92	SG3718	6/10/95	SG7815C	5/28/92
SG1495	5/28/92	SG2076	5/28/92	SG305A	5/28/92	SG3821	5/28/92	SG7818C	5/28/92
SG1496	5/28/92	SG2077	5/28/92	SG3086	5/28/92	SG3825	5/28/92	SG7820C	5/28/92
SG150	5/28/92	SG2101A	5/28/92	SG311	5/28/92	SG3840	5/28/92	SG7824C	5/28/92
SG1501A	8/17/93	SG211	5/28/92	SG3172	8/17/93	SG3847	5/28/92	SG7905C	5/28/92
SG1502	5/28/92	SG2111	5/28/92	SG3173	5/28/92	SG4501	5/28/92	SG7906C	5/28/92
SG150A	5/28/92	SG2172	5/28/92	SG317AHV	5/28/92	SG508	5/28/92	SG7908C	5/28/92
SG1528	5/28/92	SG2173	5/28/92	SG317HV	5/28/92	SG510A4	8/17/93	SG7912C	5/28/92
SG1530	5/28/92	SG217HV	5/28/92	SG3183	5/28/92	SG510AR4	8/17/93	SG7915C	5/28/92
SG1542	5/28/92	SG217AHV	5/28/92	SG320	5/28/92	SG541	8/17/93	SG7918C	5/28/92
SG1557	5/28/92	SG224	5/28/92	SG3212	5/28/92	SG55234	5/28/92	SG7920C	5/28/92
SG1559	5/28/92	SG224A	5/28/92	SG324	5/28/92	SG55234A	5/28/92	SG7924C	5/28/92
SG1560	5/28/92	SG238	5/28/92	SG324A	5/28/92	SG55236A	5/28/92		

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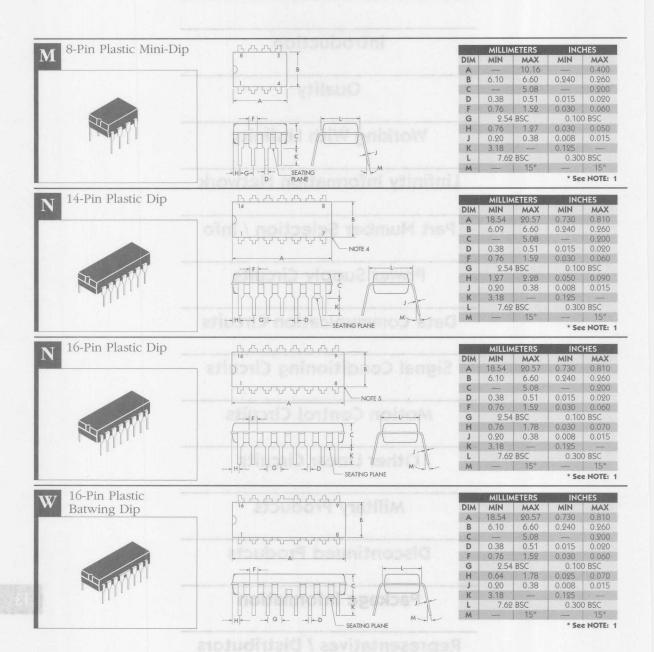
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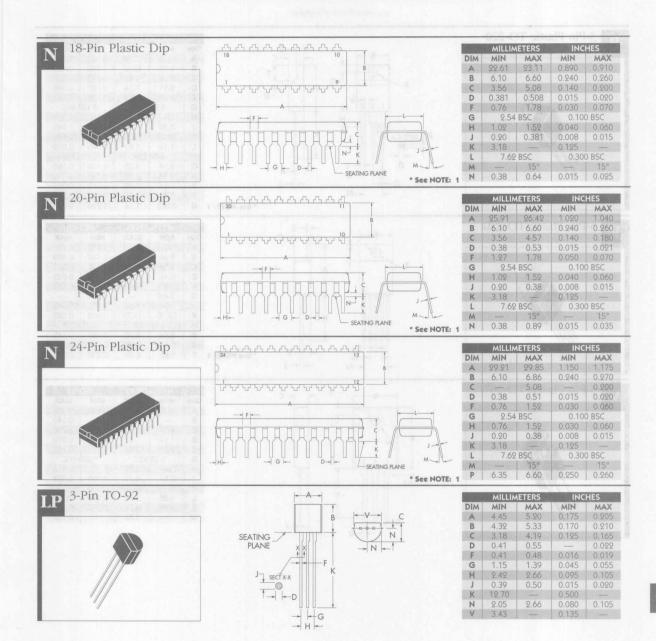
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### MECHANICAL DIMENSIONS



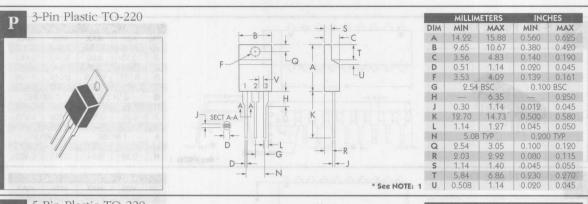


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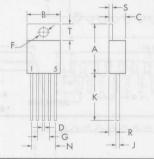




### MECHANICAL DIMENSIONS

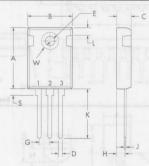






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	DIM	MIN	MAX	MIN	MAX
	A	14.23	16.51	0.560	0.650
	В	9.66	10.66	0.380	0.420
	C	3.56	4.82	0.140	0.190
	D	0.46	0.89	0.018	0.035
	F	3.56	4.06	0.140	0.160
	G	3.40		0.134	-
	J	0.31	1.14	0.012	0.045
	K	12.70	14.73	0.500	0.580
	N	6.80	TYP	0.268	B TYP
	R	2.04	2.92	0.080	0.115
	S	1.14	1.39	0.045	0.055
ee NOTE: 1	T	5.85	6.85	0.230	0.270

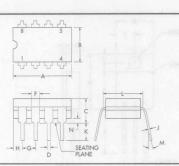




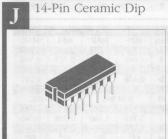
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DIM	MIN	MAX	MIN	MAX	
A	20.83	21.34	0.820	0.840	
В	- 1	16.26	-	0.640	
C	4.93	5.33	0.190	0.210	
D	1.14	1.27	0.045	0.050	
E	3.18	3.43	0.125	0.135	
G	5.08	BSC	0.200 BSC		
Н		2.79		0.110	
J	0.51	0.71	0.020	0.028	
K	12.70	20.07	0.500	0.790	
L	3.05	3.56	0.120	0.140	
S	3.81	4.32	0.150	0.170	
W	_	3.43	-	0.135	

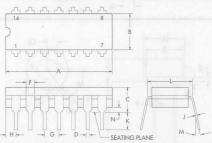




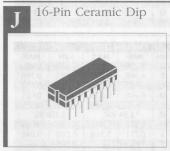


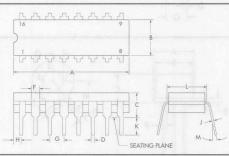
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DIM	MIN	MAX	MIN	MAX
A	9.91	10.92	0.390	0.430
В	5.59	7.11	0.220	0.280
C	4.32	5.08	0.170	0.200
D	0.38	0.51	0.015	0.020
F	1.02	1.78	0.040	0.070
G	2.54	TYP	0.100 TYP	
H	1.14	1.65	0.045	0.065
J	0.20	0.38	0.008	0.015
K	3.18	4.06	0.125	0.160
L	7.37	7.87	0.290	0.310
M		15°		15°
N	0.51	1.02	0.020	0.040



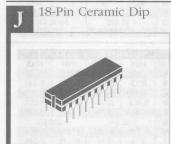


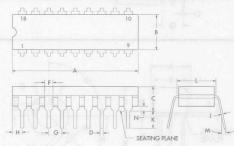
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DIM	MIN	MAX	MIN	MAX
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В	5.59	7.11	0.220	0.280
C		5.08		0.200
D	0.38	0.51	0.015	0.020
F	1.02	1.77	0.040	0.070
G	2.54	TYP	0.100 TYP	
H		2.03		0.080
J	0.20	0.38	0.008	0.015
K	3.17	5.08	0.125	0.200
L	7.37	7.87	0.290	0.310
M	-	15°		15°
N	0.51	0.76	0.020	0.030



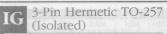


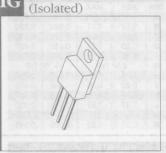
	MILLIM	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	19.30	19.94	0.760	0.785
В	5.59	7.11	0.220	0.280
C		5.08		0.200
D	0.38	0.51	0.015	0.020
F	0.76	1.77	0.030	0.070
G	2.54	ТУР	0.100 TYP	
H		2.03		0.080
J	0.20	0.38	0.008	0.015
K	3.18	5.08	0.125	0.200
L	7.37	7.87	0.290	0.310
M		15°		15°
N	0.51	0.76	0.020	0.030

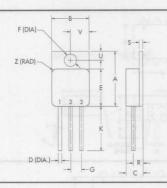




	MILLIA	AETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A		24.38		0.960
В	5.59	7.11	0.220	0.280
C		5.08	N-05	0.200
D	0.38	0.51	0.015	0.020
F	0.76	1.78	0.030	0.070
G	2.54	1 TYP	0.10	O TYP
H		2.03		0.080
J	0.20	0.38	0.008	0.015
K	3.18	5.08	0.125	0.200
L	7.37	7.87	0.290	0.310
M		15°		15°
N	0.51	0.76	0.020	0.030



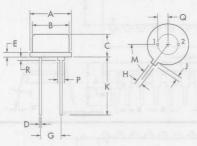




1000	MILLIM	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	16.38	16.64	0.645	0.655
В	10.41	10.67	0.410	0.420
C	4.70	4.95	0.185	0.195
D	0.71	0.81	0.028	0.032
E	10.41	10.67	0.410	0.420
F	3.56	3.81	0.140	0.150
G	2.54	TYP	0.100 TYP	
K	12.70		0.500	B:
N	5.08	ТУР	0.200 TYP	
R	2.92	3.18	0.115	0.125
S	0.89	1.43	0.035	0.045
U	2.87	3.12	0.113	0.123
V	5.13	5.38	0.202	0.212
Z	1.40	TYP	0.05	5 TYP

2-Pin Metal Can TO-46

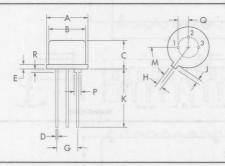




63.5	MILLIM	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	5.308	5.588	0.209	0.220
В	4.648	5.029	0.183	0.198
C		2.667	-	0.105
D	0.406	0.533	0.016	0.021
E		0.381		0.015
G	2.54	BSC	0.100 BSC	
H	0.914	1.143	0.036	0.045
J	0.711	1.168	0.028	0.046
K	12.70	-	0.500	
M	42°	48°	42°	48°
P		1.19		0.047
Q	1.27	TYP	0.05	O TYP
R		0.381		0.015

3-Pin Metal Can TO-52

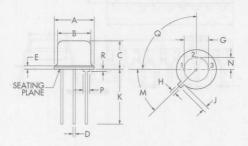




	_		
MILLIM	ETERS	INC	HES
MIN	MAX	MIN	MAX
5.308	5.588	0.209	0.220
4.648	5.029	0.183	0.198
	4.064		0.160
0.406	0.533	0.016	0.021
	0.381		0.015
2.54	BSC	0.100 BSC	
0.914	1.143	0.036	0.045
0.711	1.168	0.028	0.046
12.70		0.500	
42°	48°	42°	48°
	1.193	41	0.047
1.27 TYP		0.050 TYP	
	0.381		0.015
	MIN 5.308 4.648  0.406  2.54 0.914 0.711 12.70 42°	5.308 5.588 4.648 5.029 — 4.064 0.406 0.533 — 0.381 2.54 BSC 0.914 1.143 0.711 1.168 12.70 — 42° 48° — 1.193 1.27 TyP	MIN MAX MIN 5.308 5.588 0.209 4.648 5.029 0.183 4.064 0.533 0.016 0.381 2.54 BSC 0.100 0.914 1.143 0.036 0.711 1.168 0.028 12.70 0.500 42° 48° 42° 1.193 1.27 Typ 0.050

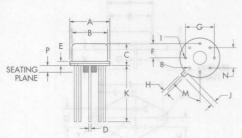
3-Pin Metal Can TO-39





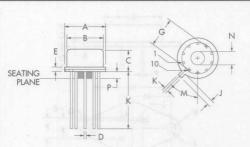
	MILLIM	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	8.89	9.40	0.350	0.370
В	8.13	8.51	0.320	0.335
C	4.19	4.70	0.165	0.185
D	0.406	0.533	0.016	0.021
E		1.02		0.040
G	5.08 BSC		0.200 BSC	
Н	0.711	0.864	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	14.48	0.500	0.570
M	45°	TYP	45°	TYP
N	2.54	TYP	0.100	) TYP
P		1.143		0.045
Q	90°	TYP	90°	TYP
R		0.635	-	0.025





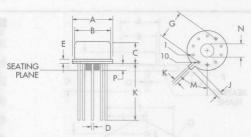
	MILLIM	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	8.89	9.40	0.350	0.370
В	8.00	8.51	0.315	0.335
C	4.191	4.699	0.165	0.185
D	0.406	0.533	0.016	0.021
E	-	1.016		0.040
F	2.54	TYP	0.100 TYP	
G	5.08	TYP	0.200 TYP	
Н	0.711	0.864	0.028	0.034
J	0.737	1.14	0.029	0.045
K	12.70	14.48	0.500	0.570
M	45°	TYP	45°	TYP
N	3.556	4.064	0.140	0.160
P	0.254	1.016	0.010	0.040





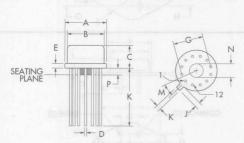
	MILLIN	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	8.890	9.398	0.350	0.370
В	8.00	8.51	0.315	0.335
C	4.191	4.699	0.165	0.185
D	0.406	0.533	0.016	0.021
E	_	1.016	-	0.040
G	5.849	2 TYP	0.230 TYP	
H	0.711	0.864	0.028	0.034
J	0.737	1.143	0.029	0.045
K	12.70	14.48	0.500	0.570
M	36°	TYP	36°	ТУР
N	3.556	4.064	0.140	0.160
P	0.254	1.016	0.010	0.040





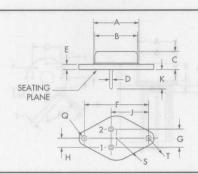
	MILLIN	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	8.890	9.398	0.350	0.370
В	8.00	8.51	0.315	0.335
C	6.096	6.604	0.240	0.260
D	0.406	0.533	0.016	0.021
E		1.016		0.040
G	5.849	2 TYP	0.230 TYP	
H	0.711	0.636	0.028	0.034
J	0.737	1.143	0.029	0.045
K	12.70	14.48	0.500	0.570
M	36° TYP		36°	TYP
N	3.556	4.064	0.140	0.160
P	0.254	1.016	0.010	0.040





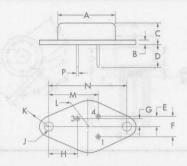
	MILLIN	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	8.89	9.40	0.350	0.370
В	8.00	8.51	0.315	0.335
C	4.191	4.699	0.165	0.185
D	0.406	0.533	0.016	0.021
E	-	1.016		0.040
G	5.849	2 TYP	0.230 TYP	
H	0.711	0.864	0.028	0.034
J	0.737	1.143	0.029	0.045
K	12.70	14.48	0.500	0.570
M	36° TYP		36°	TYP
N	3.556	4.064	0.140	0.160
P	0.254	1.016	0.010	0.040





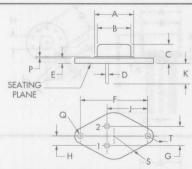
STATE OF THE PARTY OF	MILLIM	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A		23.62	-	0.930
В	19.43	19.68	0.765	0.775
C	6.86	7.62	0.270	0.300
D	0.97	1.09	0.038	0.043
E	1.52	2.03	0.060	0.080
F	29.90	30.40	1.177	1.197
G	10.67	11.18	0.420	0.440
H	5.21	5.72	0.205	0.225
J	16.64	17.14	0.655	0.675
K	10.79	12.19	0.425	0.480
Q	3.84	4.09	0.151	0.161
S	12.57	13.34	0.495	0.525
T	4.06R	4.57R	0.160R	0.180R



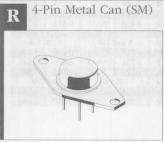


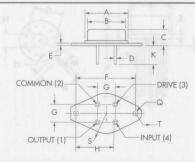
SE VOI	MILLIA	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	19.30	19.81	0.760	0.780
В	1.52	1.65	0.060	0.065
C	8.12	8.63	0.320	0.340
D	10.80	12.06	0.425	0.475
E	5.21	5.72	0.205	0.225
F	10.67	11.18	0.420	0.440
G	3.680	4.190	0.145	0.165
H	10.03	10.29	0.395	0.405
J	0.396	0.439	0.156	0.173
K	-	4.39R		0.173R
L		13.34		0.525
M	17.98	18.49	0.708	0.728
N	30.07	30.23	1.184	1.190
P	0.970	1.090	0.038	0.043





-	MILLIA	METERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A		15.75	-	0.620
В	11.94	12.70	0.470	0.500
C	6.60	7.62	0.260	0.300
D	0.71	0.86	0.028	0.034
E	1.27	1.91	0.050	0.075
F	24.33	24.43	0.958	0.962
G	4.83	5.33	0.190	0.210
H	2.36	2.72	0.093	0.107
J	14.48	14.99	0.570	0.590
K	9.14	10.41	0.360	0.410
P		0.635		0.025
Q	3.61	3.86	0.142	0.152
S		8.89R		0.350R
T	_	3.68R		0.145R



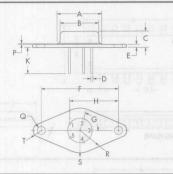


166	MILLIA	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A		15.75		0.620
В	11.94	12.70	0.470	0.500
C	6.60	7.62	0.260	0.300
D	0.71	0.86	0.028	0.034
E	1.27	1.91	0.050	0.075
F	24.13	24.64	0.950	0.970
G	5.08	TYP	0.200 TYP	
H	14.48	14.99	0.570	0.590
K	9.398	9.906	0.370	0.390
Q	3.607	3.861	0.142	0.152
S		8.89R	_	0.350R
T	-	3.55R	_	0.140R



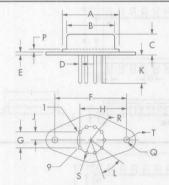
### MECHANICAL DIMENSIONS



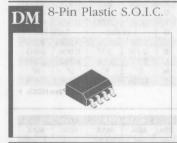


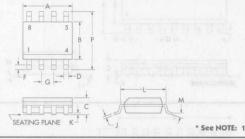
	MILLIM	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A		15.75		0.620
В	11.94	12.70	0.470	0.500
C	6.60	7.62	0.260	0.300
D	0.71	0.86	0.028	0.034
E	1.27	1.90	0.050	0.075
F	24.33	24.43	0.958	0.962
G	72°	TYP	72° TYP	
Н	14.48	14.99	0.570	0.590
K	9.14	10.41	0.360	0.410
P		0.635		0.025
Q	3.607	3.861	0.142	0.152
R		4.11R	_	0.162R
S	_	8.89R		0.350R
T		3.55R	_	0.140R



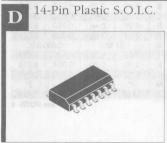


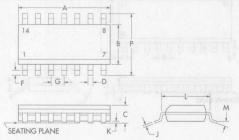
	MILLIA	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	-	15.75		0.620
В	11.94	12.70	0.470	0.500
C	6.60	7.62	0.260	0.300
D	0.71	0.86	0.028	0.034
E	1.270	1.905	0.050	0.075
F	24.33	24.43	0.958	0.962
G	4.826	5.334	0.190	0.590
H	14.48	14.99	0.570	0.590
J	2.362	2.718	0.093	0.107
K	9.14	10.41	0.360	0.410
L	36°	TYP	36° TYP	
P	_	0.635		0.025
Q	3.607	3.861	0.142	0.152
R		4.11R	-	0.162R
S		8.89R		0.350R
T	_	3.683R	_	0.145R





	MILLIM	METERS	INC	HES	
DIM	MIN	MAX	MIN	MAX	
A	4.65	5.13	0.183	0.202	
В	3.66	4.14	0.144	0.163	
C	1.73	1.88	0.068	0.074	
D	0.25	0.51	0.010	0.020	
F	0.38	0.89	0.015	0.035	
G	1.27	BSC	0.050 BSC		
J	0.19	0.25	0.007	0.010	
K	0.13	0.25	0.005	0.010	
L	4.80	5.21	0.189	0.205	
M		8°	net l	8°	
P	5.79	6.20	0.228	0.244	

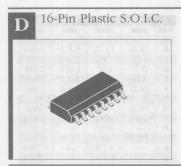


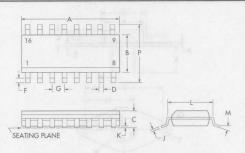


	MILLIA	METERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	8.54	8.74	0.336	0.344
В	3.81	4.01	0.150	0.158
C	1.35	1.75	0.053	0.069
D	0.35	0.46	0.014	0.018
F	0.67	0.77	0.026	0.030
G	1.27	BSC	0.050 BSC	
J	0.19	0.25	0.007	0.010
K	0.10	0.25	0.004	0.010
L	4.82	5.21	0.189	0.205
M	0°	8°	0°	8°
P	5.79	6.20	0.228	0.244



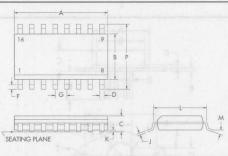
### PRODUCT DATABOOK 1996/1997





HE	MILLIA	METERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	9.78	10.01	0.385	0.394
В	3.81	4.01	0.150	0.158
C	1.35	1.75	0.053	0.069
D	0.35	0.46	0.014	0.018
F	0.51	0.77	0.020	0.030
G	1.27	BSC	0.050 BSC	
J	0.19	0.25	0.007	0.010
K	0.10	0.25	0.004	0.010
L	4.82	5.21	0.189	0.205
M	0°	8°	0°	8°
P	5.79	6.20	0.228	0.244
			* Se	e NOTE:

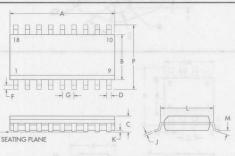
DW 16-Pin Plastic (SOWB) Widebody S.O.I.C.



	MILLIM	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A		10.67		0.420
В	7.49	7.75	0.295	0.305
C	2.35	2.65	0.093	0.104
D	0.25	0.46	0.010	0.018
F	0.64	0.89	0.025	0.035
G	1.27	BSC	0.050	D BSC
J	0.23	0.32	0.009	0.013
K	0.10	0.30	0.004	0.019
L	8.13	8.64	0.320	0.340
M	0°	8°	0°	8°
P	10.26	10.65	0.404	0.419

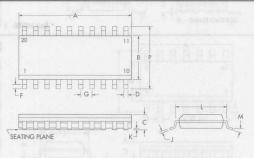
\* See NOTE: 1





	MILLIN	ETERS	INC	HES
MIC	MIN	MAX	MIN	MAX
A		13.21		0.520
В	7.49	7.75	0.295	0.305
C	2.35	2.65	0.093	0.104
D	0.25	0.46	0.010	0.018
F	0.64	0.89	0.025	0.035
G	1.27	BSC	0.050 BSC	
J	0.23	0.32	0.009	0.013
K	0.10	0.30	0.004	0.012
L	8.13	8.64	0.320	0.340
M	0°	8°	0°	8°
P	10.26	10.65	0.404	0.419

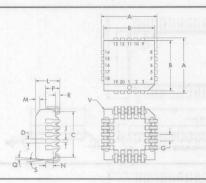




	MILLIA	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A		13.21	_	0.520
В	7.49	7.75	0.295	0.305
C	2.35	2.65	0.093	0.104
D	0.25	0.46	0.010	0.018
F	0.64	0.89	0.025	0.035
G	1.27	BSC	0.050 BSC	
1	0.23	0.32	0.009	0.013
K	0.10	0.30	0.004	0.012
L	8.13	8.64	0.320	0.340
M	0°	8°	0°	8°
P	10.26	10.65	0.404	0.419
		100	* Se	e NOTE:

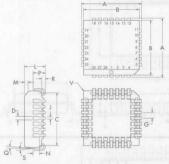






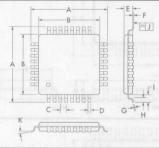
	MILLIM	ETERS	INCHES	
DIM	MIN	MAX	MIN	MAX
A	9.70	10.03	0.382	0.395
В	8.89	9.04	0.350	0.356
C	7.37	8.38	0.290	0.330
D	0.66	0.81	0.026	0.032
G	1.27	TYP	0.050 TYP	
J	0.33	0.53	0.013	0.021
L	4.06	4.78	0.160	0.188
M	1.27	TYP	0.05	O TYP
N	1.52		0.060	
P	2.41		0.095	_
Q	3	0	3	0
R	0.63	1.14	0.025	0.045
S	3	0	3	0
٧		0.51	_	0.020





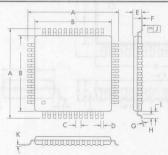
1	MILLIM	METERS INCHES		
DIM	MIN	MAX	MIN	MAX
A	12.19	12.70	0.480	0.500
В	11.43	11.56	0.450	0.455
C	10.54	10.92	0.415	0.430
D	0.64	0.89	0.025	0.035
G	1.27 TYP		0.050 TYP	
J	0.33	0.53	0.013	0.021
L	4.06	4.83	0.160	0.190
M	1.14	-	0.045	-
N	0.76	1.27	0.030	0.050
P	2.41	_	0.095	
Q	3°	6°	3°	6°
R	0.63	1.14	0.025	0.045
S	3°	6°	3°	6°
٧		0.51	_	0.020





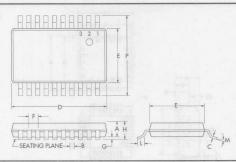
	MILLIA	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	8.90	9.10	0.350	0.358
В	6.90	7.10	0.272	0.280
C	0.80	TYP	0.03	1 TYP
D	0.30	0.45	0.012	0.018
E	1.35	1.45	0.053	0.057
F	0.05	0.15	0.002	0.006
G	0.090	0.200	0.004	0.008
Н	0.45	0.75	0.018	0.030
1	1.00 TYP		0.03	9 TYP
J		0.08		0.003
K	0°	70	0°	7°





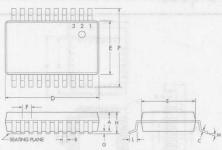
	MILLIN	METERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	8.90	9.10	0.350	0.358
В	6.90	7.10	0.272	0.280
C	0.50	TYP	0.02	O TYP
D	0.17	0.27	0.007	0.012
E	1.35	1.45	0.053	0.057
F	0.05	0.15	0.002	0.006
G	0.090	0.200	0.004	0.008
Н	0.45	0.75	0.018	0.030
1	1.00 TYP		0.03	9 TYP
J	_	0.08		0.003
K	0°	7°	0°	7°





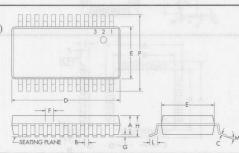
	MILLIN	METERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A		0.90		0.354
В	0.18	0.30	0.0071	0.0118
C	0.90	0.180	0.0035	0.0071
D	6.40	6.60	0.252	0.260
E	4.30	4.48	0.169	0.176
F	0.65	BSC	0.02	5 BSC
G	0.05	0.15	0.002	0.005
H	_	1.10	_	0.0433
L	0.50	0.70	0.020	0.028
M	0°	8°	0°	8°
P	6.25	6.50	0.246	0.256





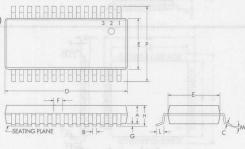
	MILLIN	METERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	1.73	1.99	0.068	0.078
В	0.25	0.38	0.009	0.015
C	0.13	0.22	0.005	0.008
D	7.07	7.33	0.278	0.288
E	5.20	5.38	0.205	0.212
F	0.65	BSC	0.02	5 BSC
G	0.05	0.21	0.002	0.008
Н	1.63	1.83	0.064	0.079
L	0.65	0.95	0.025	0.037
M	0°	8°	0°	8°
P	7.65	7.90	0.301	0.311





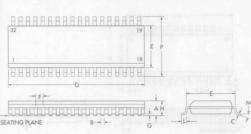
	MILLIA	METERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	1.73	1.99	0.068	0.078
В	0.25	0.38	0.009	0.015
C	0.13	0.22	0.005	0.008
D	8.07	8.33	0.318	0.328
E	5.20	5.38	0.205	0.212
F	0.65	BSC	0.02	5 BSC
G	0.05	0.21	0.002	0.008
H	1.63	1.83	0.064	0.079
L	0.65	0.95	0.025	0.037
M	0°	8°	0°	8°
P	7.65	7.90	0.301	0.311





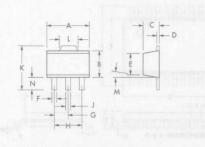
	MILLIN	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	1.73	1.99	0.068	0.078
В	0.25	0.38	0.009	0.015
C	0.13	0.22	0.005	0.008
D	10.07	10.33	0.396	0.407
E	5.20	5.38	0.205	0.212
F	0.65	BSC	0.02	5 BSC
G	0.05	0.21	0.002	0.008
Н	1.63	1.83	0.064	0.072
L	0.65	0.95	0.025	0.037
M	0°	8°	0°	8°
P	7.65	7.90	0.301	0.311





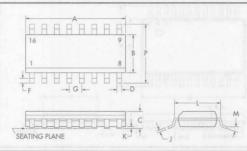
	MILLIM	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	2.31		0.091	
В	0.29	0.39	0.011	0.015
C	0.23	0.32	0.0091	0.0125
D	15.20	15.40	0.598	0.606
E	7.40	7.60	0.291	0.299
F	0.80	BSC	0.03	1 BSC
G	0.13		0.005	
Н	2.44	2.64	0.096	0.104
L	0.51	1.01	0.020	0.040
M	0°	8°	0°	8°
P	10.11	10.51	0.398	0.414



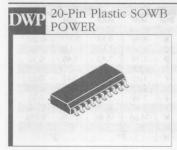


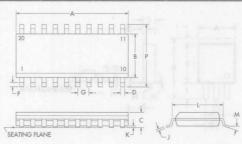
	MILLIA	METERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	4.39	4.59	0.173	0.181
В	2.28	2.59	0.090	0.102
C	1.39	1.60	0.055	0.063
D	0.38	0.43	0.015	0.017
E	2.13	2.28	0.084	0.090
F	0.33	0.48	0.016	0.019
G	1.49	BSC	0.05	9 BSC
H	2.99	BSC	0.118 BSC	
J	0.45	0.55	0.018	0.022
K	3.94	4.24	0.155	0.167
L	1.70	1.82	0.067	0.072
M	0°	8°	0°	8°
N	0.89	1.19	0.035	0.047



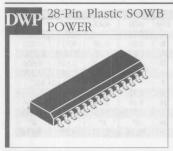


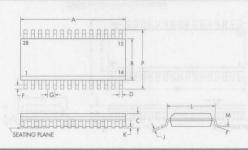
	MILLIA	METERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	9.78	10.01	0.385	0.394
В	3.81	4.01	0.150	0.158
C	1.35	1.75	0.053	0.069
D	0.35	0.46	0.014	0.018
F	0.51	0.77	0.020	0.030
G	1.27	BSC	0.050 BSC	
J	0.19	0.25	0.007	0.010
K	0.10	0.25	0.004	0.010
L	4.82	5.21	0.189	0.205
M	0°	8°	0°	8°
P	5.79	6.20	0.228	0.244





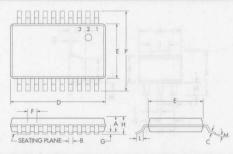
1	MILLIM	METERS	INCHES	
DIM	MIN	MAX	MIN	MAX
A		13.21		0.520
В	7.49	7.75	0.295	0.305
C	2.35	2.65	0.093	0.104
D	0.25	0.46	0.010	0.018
F	0.64	0.89	0.025	0.035
G	1.27	BSC	0.050 BSC	
J	0.23	0.32	0.009	0.013
K	0.10	0.30	0.004	0.019
L	8.13	8.64	0.320	0.340
M	0°	8°	0°	8°
P	10.26	10.65	0.404	0.419



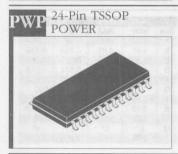


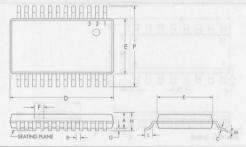
TER	MILLIM	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	17.73	17.93	0.698	0.705
В	7.40	7.60	0.291	0.299
C	2.44	2.64	0.096	0.104
D	0.36	0.46	0.014	0.018
F	0.51	1.01	0.020	0.040
G	1.27	BSC	0.05	0 BSC
J	0.123	0.32	0.005	0.013
K	0.10	0.30	0.004	0.019
L	8.13	8.64	0.320	0.390
M	0°	8°	0°	8°
P	10.26	10.65	0.404	0.419





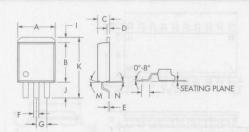
	MILLIA	METERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A		0.90		0.354
В	0.18	0.30	0.0071	0.0118
C	0.90	0.180	0.0035	0.0071
D	6.40	6.60	0.252	0.260
E	4.30	4.48	0.169	0.176
F	0.65	BSC	0.02	5 BSC
G	0.05	0.15	0.002	0.005
H	-	1.10		0.0433
L	0.50	0.70	0.020	0.028
M	0°	8°	0°	8°
P	6.25	6.50	0.246	0.256





	MILLIM	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	1.73	1.99	0.068	0.078
В	0.25	0.38	0.009	0.015
C	0.13	0.22	0.005	0.008
D	7.70	7.90	0.303	0.311
E	5.20	5.38	0.205	0.212
F	0.65	BSC	0.025 BSC	
G	0.05	0.21	0.002	0.008
H	1.63	1.83	0.064	0.072
L	0.65	0.95	0.025	0.037
M	0°	8°	00	8°
P	7.65	7.90	0.301	0.311

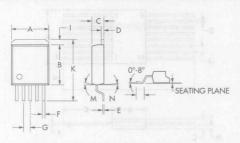




	MILLIN	METERS	INCHES	
DIM	MIN	MAX	MIN	MAX
A	10.41	10.67	0.410	0.420
В	8.92	9.17	0.351	0.361
C	4.34	4.59	0.171	0.181
D	1.14	1.40	0.45	0.55
E	0.330	0.432	0.013	0.017
F	1.19	1.34	0.47	0.53
G	2.41	2.66	0.95	0.105
1	1.14	1.40	0.45	0.55
J	2.33	4.98	0.192	0.196
K	14.60	15.87	0.575	0.625
M	7	10	7	0
N	3	0	3	0

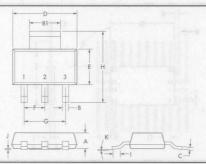
### MECHANICAL DIMENSIONS



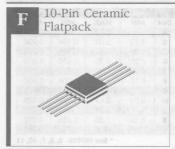


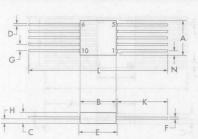
	MILLIM	ETERS	INC	HES
MID	MIN	MAX	MIN	MAX
A	10.16	10.67	0.400	0.420
В	8.92	9.17	0.351	0.361
C	4.34	4.59	0.171	0.181
D	1.14	1.40	0.45	0.55
E	0.330	0.432	0.013	0.017
F	0.737	0.889	0.029	0.035
G	1.57	1.83	0.062	0.072
1	1.14	1.40	0.45	0.55
K	14.60	15.87	0.575	0.625
M	7	10	7	70
N	3	0	3	30





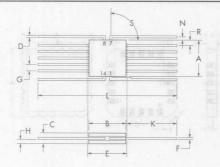
	MILLIM	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	1.55	1.80	0.061	0.071
В	0.65	0.85	0.026	0.033
B1	2.95	3.15	0.116	0.124
C	0.25	0.35	0.010	0.014
D	6.30	6.70	0.248	0.264
E	3.30	3.70	0.130	0.146
F	0.230	BSC	0.0905 BSC	
G	4.60	BSC	0.181	BSC
H	6.71	7.29	0.264	0.287
1	_	0.91	-	0.36
J	0.02	0.10	0.0008	0.004
K	10°	MAX	10° /	VAX





	MILLIA	ETERS	INC	HES
MIC	MIN	MAX	MIN	MAX
A		7.37		0.290
В	6.04	6.40	0.238	0.252
C	1.45	1.70	0.057	0.067
D	0.25	0.483	0.010	0.019
E		6.91		0.272
F	0.076	0.153	0.003	0.006
G	1.27	TYP	0.050 TYP	
H	0.51	1.02	0.020	0.040
K	6.35	9.40	0.250	0.370
L	18.74	25.4	0.738	1.000
N	0.20	0.38	0.008	0.015



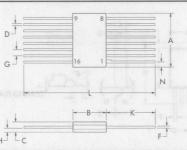


NAME OF TAXABLE PARTY.	MILLIM	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A		7.11		0.280
В	6.10	6.40	0.240	0.252
C	1.45	1.70	0.057	0.067
D	0.25	0.483	0.010	0.019
E	_	6.91		0.272
F	0.08	0.15	0.003	0.006
G	1.27	TYP	0.050 TYP	
Н	0.51	1.02	0.020	0.040
K	6.35	9.40	0.250	0.370
L	19.0	25.4	0.75	1.000
N	0.10	-	0.004	
R	0.13	_	0.005	_
S	30°	90°	30°	90°

\* See NOTES: 2, 5, 6, 7, 8, 9



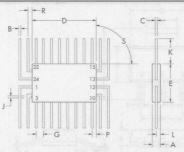




A FEB	MILLIM	ETERS	INC	HES°
DIM	MIN	MAX	MIN	MAX
A		10.16		0.400
В	6.27	6.63	0.247	0.261
C	1.65	1.91	0.065	0.075
D	0.38	0.48	0.015	0.019
F	0.08	0.15	0.003	0.006
G	1.27	BSC	0.050 BSC	
H	0.51	1.02	0.020	0.040
K	6.35	9.40	0.250	0.370
L	18.97	25.4	0.747	1.000
N	0.20	0.38	0.008	0.015

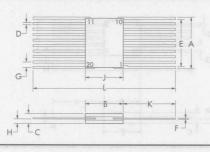
\* See NOTES: 2, 3





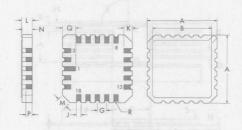
	MILLIN	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	1.650	1.900	0.065	0.075
В	0.380	0.480	0.015	0.019
C	0.080	0.150	0.003	0.006
D		11.18	_	0.440
E	6.27	6.63	0.247	0.261
G	1.27	BSC	0.050 BSC	
J	0.200	0.380	0.008	0.015
K	6.350	9.400	0.250	0.370
L	0.510	1.020	0.020	0.040
P	0.130		0.005	_
R	0.100		0.004	10.23
S	30°	90°	30°	90°

F 20-Pin Ceramic Flatpack



	MILLIM	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A		7.33	STATE OF THE PARTY	0.288
В	4.93	5.09	0.194	0.200
C	1.14	1.91	0.045	0.075
D	0.25	0.38	0.010	0.015
E	6.92	7.07	0.272	0.278
F	0.10	0.15	0.004	0.006
G	0.76	ТУР	0.03	O TYP
H	0.50	0.64	0.020	0.025
J		5.34		0.210
K	6.74	7.38	0.265	0.290
L	18.42	19.85	0.724	0.780





	MILLIA	ETERS	INC	HES
DIM	MIN	MAX	MIN	MAX
A	8.64	9.14	0.340	0.360
В	- 1	8.128	_	0.320
G	1.27	O TYP	0.050 TYP	
J	0.63	5 TYP	0.025 TYP	
K	1.02	1.52	0.040	0.060
L	1.626	2.286	0.064	0.090
M	1.01	5 TYP	0.04	O TYP
N	1.372	1.68	0.054	0.066
P		1.168		0.046
Q	1.91	2.41	0.075	0.095
R	0.2	03R	0.0	08R

\* See NOTE: 18



#### MECHANICAL DIMENSIONS

#### PACKAGE DRAWING NOTES

- These points are reference datums on the molded body and do not include mold flash or protrusions. Mold flash and protruions shall not protrusions.
- sions shall not exceed 0.15mm (.006") on any side. **2.** Lead No.1 is identified by tab on lead or dot on cover.
- **3.** Leads are within 0.13mm (0.005") radius of the true position (TP) at maximum material condition.
- **4.** Dimension "G" determines a zone within which all body and lead irregularities lie.
- 5. Dimension "E" allows for off-center lid, meniscus and glass overrun
- 6. Dimension "N" applies to leads 1, 7, 8, and 14.
- Dimension "H" is measured at the point of exit of the lead from the body.
- 8. Dimension "R" applies to all four corners.
- **9.** Dimension "G" is the basic pin spacing between center lines in twelve positions.

- 10. Dimensions "A" and "J" allow for off-center lid, meniscus, and glass overrun.
- 11 Dimension "G" eighteen spaces.
- **12.** Dimension "L" shall be measured at the point of exit of the lead from the body.
- 13. Dimension "D" allows for off-center lid, meniscus and glass overrun.
- **14.** The basic pin spacing is 0.050" (1.27mm) between centerlines. Each pin centerline shall be located within ±0.005" (0.13mm) of its exact longitudinal position relative to pins 1 and 24.
- 15. Dimension "P" applies to all four corners (leads 3, 10, 15, and 22.)
- 16. Dimension "R" applies to leads 2, 11, 14, and 23.
- 17. Dimension "S" applies to leads 1, 2, 11, 12, 13, 14, 23, and 24.
- 18. All exposed metallized area shall be gold plated 60 micro-inch minimum thickness over nickel plated unless otherwise specified purchase order.

For more information concerning package outlines and dimensions, please contact Linifinity per instructions below.



714-898-8121

Package Information Line

- 1. Identify your call as a Package Dimension / Package Outline Question.
- 2. Provide the package type and/or identifier. (e.g., SOIC DW Package)
- 3. The receptionist will forward your call to the appropriate Engineer.

#### IDENTIFICATION OF OFF-SHORE ASSEMBLY LOCATIONS

Linfinity utilizes several off-shore locations to perform assembly and environmental screening operations. This assembly site is identified on the device or unit packaging label according to the following codes:

Country	Preferred Abbreviations	Limited Space Abbreviations		
Korea	KOR	A		
Philippines	PHIL	S or T		
Thailand	THAI	В		
U.S.A.	USA	G		



TUBE QUANTITIES / SURFACE-MOUNT TAPE & REEL INFORMATION

#### TUBE QUANTITIES

Package Designator	Package Type	Parts per Tube	Package Designator	Package Type	Parts per Tube
М	8-pin Plastic DIP	50	D	14-pin Plastic SOIC	55
N	14-pin Plastic DIP	25	D	16-pin Plastic SOIC	50
N	16-pin Plastic DIP	25	DW	16-pin Plastic SOWB	46
N	18-pin Plastic DIP	21	DW	18-pin Plastic SOWB	41
N	20-pin Plastic DIP	18	DW	20-pin Plastic SOWB	37
N	24-pin Plastic DIP	16	Q	20-pin PLCC	48
W	16-pin Plastic Batwing DIP	25	Q	28-pin PLCC	39
Р	3 & 5-pin Plastic TO-220	50	Q	44-pin PLCC	27
٧	3-pin Plastic TO-247	30	PW	20-pin TSSOP	74
У	8-pin Ceramic DIP	50	PWP	24-pin TSSOP	62
J	14-pin Ceramic DIP	25	DP	16-pin Power SOIC	47
J	16-pin Ceramic DIP	25	DWP	20-pin Power SOWB	37
J	18-pin Ceramic DIP	21	DWP	28-pin Power SOWB	27
IG	3-pin TO-257 (Hermetic TO-220)	50	DD	3-pin Surface Mount TO-263AA	50
DM	8-pin Plastic SOIC	100	ST	3-pin SOT-223	78

TAPE & REEL DIMENSIONS / QUANTITIES

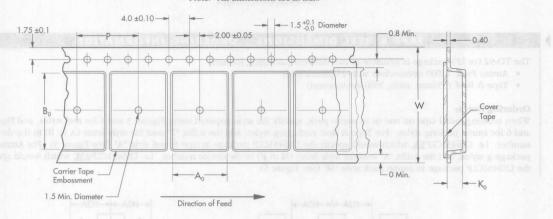
Package Designator	Package Type	Tape Width (W)	Pkg. Pitch (P)	Pocket Width (A <sub>o</sub> )	Dim. Length $(\mathrm{B}_{\mathrm{o}})$	Depth (K <sub>o</sub> )	Reel Diameter	Reel Hub Diameter (N)	Parts per Ree
DM	8-pin SOIC	12	8	6.4	5.2	2.1	330	100	2500
D	14-pin SOIC	16	8	6.5	9.0	2.1	330	100	2500
D	16-pin SOIC	16	8	6.5	10.3	2.1	330	100	2500
DW	16-pin SOWB	16	12	10.9	10.7	3.0	330	100	1000
DW	18-pin SOWB	24	12	10.9	12.1	3.0	330	100	1000
DW	20-pin SOWB	24	12	10.9	13.2	3.0	330	100	1000
Q	20-pin PLCC	16	12	10.3	10.3	4.9	330	100	1000
Q	28-pin PLCC	24	16	13.0	13.0	4.9	330	100	750
PW	20-pin TSSOP	16	12	8.2	8.1	2.5	330	100	1500
DB	20-pin SSOP	16	12	8.2	8.1	2.5	330	100	1500
DB	24-pin SSOP	16	12	8.2	9.1	2.5	330	100	1500
DB	28-pin SSOP	16	12	8.2	9.8	2.5	330	100	1000
PK	3-pin SOT-89	12	8	5.1	4.7	2.2	330	50	2500
DP	16-pin SOIC Pwr	16	8	6.5	10.3	2.1	330	100	2500
DWP	20-pin SOWB Pwr	24	12	10.9	13.2	3.0	330	100	1000
DWP	28-pin SOWB Pwr	24	12	10.9	18.3	3.0	330	100	1000
PWP	24-pin TSSOP Pwr	16	12	8.2	9.1	2.5	330	100	1500
DD	3-pin TO-263AA	24	16	10.9	16.0	5.0	330	100	750
ST	3-pin SOT-223	16	12	7	7.5	2.2	330	50	2000

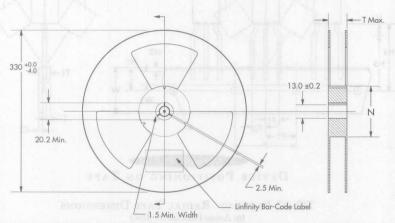
Note: All dimensions are in mm.

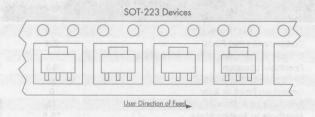


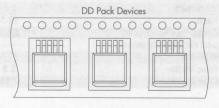
### SURFACE-MOUNT TAPE & REEL INFORMATION

Note: All dimensions are in mm.











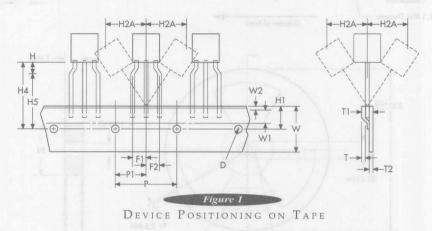
#### TAPE & REEL DIMENSIONS / ORDERING INFORMATION

The TO-92 (or LP) package is available in two different packaging formats:

- Ammo Pack (2000 devices/box with 25 pieces/fold)
- Tape & Reel (556mm reels, 2000 devices/reel)

#### Ordering Notes:

When ordering radial tape on reel or in ammo pack, specify the style required using Figures 3 and 4 for reel styles, and Figures 5 and 6 for ammo packing styles. For Tape & Reel packaging styles, add the suffix "T" and the style letter (A or B) to the device number. i.e. LX6431CLPTA, which would specify the LX6431CLP package in tape & reel style "A" (See Figure 3). For Ammo Pack packaging styles, add the suffix "A" and the style letter (M or P) to the device number. i.e. LX6431CLPAM, which would specify the LX6431CLP package in ammo pack style "M" (See Figure 5).

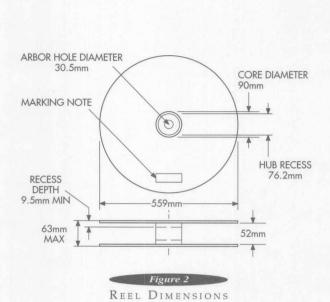


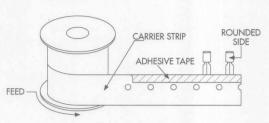
TO-92 PACKAGE RADIAL TAPE DIMENSIONS (IN AMMO PACK OR ON REEL)

		Dimensions (mm)		
ymbol	Item	Min.	Max.	
D	Tape Feedhold Diameter	3.8	4.2	
1, F2	Component Lead Pitch	2.4	2.94	
H	Bottom of Component to Seating Plane	0	5.0	
H1	Feedhole Location	8.5	9.75	
H2A	Deflection Left or Right	0	1.0	
H2B	Deflection Front or Rear	0	1.0	
H4	Feedhole to Bottom of Component	16	20.5	
H5	Feedhole to Seating Plane	15.5	16.5	
L1	Lead Wire Enclosure	2.5		
P	Feedhole Pitch	12.5	12.9	
P1	Feedhole Center to Center Lead	5.65	7.05	
T1	Overall Taped Package Thickness		0.9	
W	Carrier Strip Width	17.5	19	
W1	Adhesive Tape Width	5.5	6.3	
W2	Adhesive Tape Position	0.15	0.5	



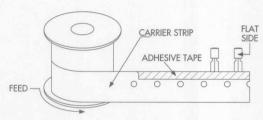
TO-92 (LP) TAPE & REEL / AMMO PACK INFORMATION





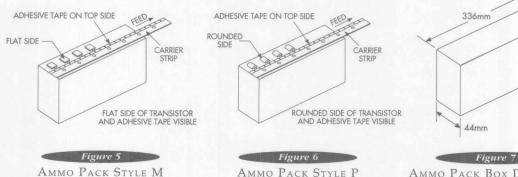
Rounded side of transistor and adhesive tape visible.

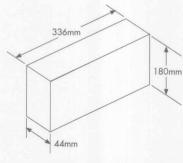
#### Figure 3 REEL STYLE A



Flat side of transistor and adhesive tape visible.

#### Figure 4 REEL STYLE B





AMMO PACK BOX DIMENSIONS

